focus on communications technology...

this month

- ssb speech processor 18
- two-meter linear 22
- fm channel scanner 29
- integrated-circuit projects 50

frequency multipliers
No other amplifier can make this statement:

- Superb Quality -
- Self-contained desk-top package -
  - Maximum legal power, continuous and conservative, all modes -
  Uniquely quiet & smooth operation with choice of two superior cooling systems...
  - The whisper-quiet, ducted-air PA70-A with thermostat control, rear intake and exhaust – $1595.
  - And the ultimate in high-powered silence, the PA70-V with exclusive recycle vapor cooling – $1775.

See the **ALPHA SEVENTY** at...

Amateur Electronic Supply, Milwaukee & Cleveland...Amrad Supply, Oakland...Douglas Electronics, Corpus Christi...Electronic Distributors, Muskegon...Harrison Radio, New York...Tech-West (K6SVT), San Diego...Disneyland Convention Sept. 4–6.
IF YOU'VE EVER USED A REPEATER,

Somewhere along the line, in virtually every ham repeater in the world, you'll find a couple of Sentry crystals.

Repeater owners and FM "old-timers" don't take chances with frequency—they can't afford to. A lot of repeater users depend on a receiver to be on frequency, rock stable...in the dead of winter or the middle of July. The repeater crowd took a tip from the commercial "pros" a long time ago—and went the Sentry Route.

That's one of the reasons you can depend on your local repeater to be there (precisely there) when you're ready to use it. FM'ers use the repeater output as a frequency standard. And for accuracy, crystals by Sentry are THE standard.

IF YOU WANT THE BEST, SPECIFY SENTRY CRYSTALS.

YOU'VE USED A Sentry Crystal

Sentry Manufacturing Company
Crystal Park, Chickasha, Oklahoma 73018

PHONE: (405) 224-6780
TWX-910-830-6425

More Details? CHECK-OFF Page 94
ANTENNA PACKAGES

BY HENRY RADIO

Optimum performance
... fast service
... guaranteed savings

For four years Henry Radio has been providing a beam antenna-tower program for amateurs who wanted an efficient, but economical package. A package pre-engineered, pre-matched and pre-packaged to his requirements and pocketbook. Thousands have benefited from this offer in the past. And now Henry Radio has researched the field and up-dated the program... including the unique new tubular design Mini Mast for less expensive installations and the great new Magna Mast for the more deluxe installations. Now you can get the latest components at the same great savings.

EASY FINANCING • 10% DOWN OR TRADE-IN DOWN • NO FINANCE CHARGE IF PAID IN 90 DAYS • GOOD RECONDITIONED EQUIPMENT • Nearly all makes and models. Our reconditioned equipment carries a 15 day trial, 90 day warranty and may be traded back within 90 days for full credit toward the purchase of NEW equipment. Write for bulletin. Export inquiries invited.

TED HENRY (W6UOU) BOB HENRY (WOARA) WALT HENRY (W6ZN)

Henry Radio

11240 W. Olympic Blvd., Los Angeles, Calif. 90064 213/477-6701
931 N. Euclid, Anaheim, Calif. 92801 714/772-9200
Butler, Missouri 64730 816/679-3127

"World's Largest Distributor of Amateur Radio Equipment"

2 August 1971

More Details? CHECK-OFF Page 94
August, 1971
volume 4, number 8

staff
James R. Fisk, W1DTY
editor
Nicholas D. Skeer, K1PSR
vhf editor
J. Jay O'Brien, W6GDO
fm editor
Alfred Wilson, W6NIF
James A. Harvey, WA6IAK
associate editors
Jean Frey
art director
Wayne T. Pierce, K3SUK
cover
T. H. Tenney, Jr. W1NLB
publisher
Hilda M. Wetherbee
advertising manager

offices
Greenville, New Hampshire 03048
Telephone 603-878-1441

ham radio magazine is published monthly by Communications Technology Inc.
Greenville, New Hampshire 03048

Subscription rates, world wide: one year, $6.00, three years, $12.00
Second class postage paid at Greenville, N. H. 03048
and at additional mailing offices.

Foreign subscription agents:
- United Kingdom: Radio Society of Great Britain,
  35 Doughty Street, London WC1, England.
  All European countries:
  Eskil Persson: SM5CJP, Frutunagrand, 1,
  19400 Upplands Vasby, Sweden.
  African continent:
  Holland Radio, 143 Greenway,
  Greenside, Johannesburg,
  Republic of South Africa

Copyright 1971 by Communications Technology, Inc.
Title registered at U. S. Patent Office.
Printed by Wellesley Press, Inc.
Wellesley, Massachusetts 02181, U.S.A.

ham radio is available to the blind and physically handicapped on magnetic tape
from Science for the Blind,
221 Rock Hill Road, Bala Cynwyd,
Pennsylvania 19401
Microfilm copies of current and back issues are available from University Microfilms,
Ann Arbor, Michigan 48103.

Postmaster: Please send form 3579 to
ham radio magazine, Greenville,
New Hampshire
03048

contents

6 frequency multipliers
Henry D. Olson, W6GXN

18 ssb speech processor
R. Bruce Clark, K6JYO

22 144-MHz linear amplifier
Robert I. Sutherland, W6UOV

29 fm channel scanner
George R. Allen, W2FPP

36 vhf coaxial filter
William I. Orr, W6SAI

40 ic function generator
James R. Fisk, W1DTY

44 low-cost printed-circuit boards
Frederick T. Swift, W6CMQ

46 ac power-line monitor
Neil A. Johnson, W20LU

50 integrated-circuit projects
Edward M. Noll, W3FQJ

58 mini-mobile
Donald J. Backys, K9UQN

4 a second look 83 flea market
94 advertisers index 60 ham notebook
50 circuits and techniques 64 new products
62 comments 94 reader service

august 1971 3
The latest application for radio is a new system developed by Sangamo Electric for automatically reading electric, gas and water meters from a cruising utility truck. The new system combines the functions of meter reading, communicating the data, and preprocessing the information on magnetic tape. The tape is used to prepare monthly bills.

The utility meters used in the automatic system are conventional watthour, gas and water meters which are equipped with an spdt switch on the numerical registers; such meters are commercially available today. The electrical pulse from the switch is accumulated in a digital counter; the output from the counter is fed into a transponder mounted on the side of the building.

The transponder is the heart of the system. It is a completely passive unit that radiates no rf energy except when interrogated once a month by a cruising utility truck. The transponder is activated by a 915-MHz signal from the truck. As long as the received signal is above a preset threshold, it re-radiates the second harmonic back to the truck's highly-directive receiving antenna.

The 1830-MHz signal from the transponder is keyed on and off by the 4-kHz pulse train from the data accumulator. A complete message from up to 12 utility meters can be received within less than 30 feet when the truck is traveling at 20 mph.

The transponder consists of two Yagi antennas on a single boom as shown in the photograph. The 4-element 915-MHz antenna is mounted below the 6-element 1830-MHz unit. The radiators of the two antennas are connected through a harmonic generator; this is the small unit in the photograph located between the second elements of each antenna.

Pilot tests being conducted in Springfield, Illinois with a prototype system indicate that, on a one-shift basis, a cruising utility truck can automatically record data from 100,000 meters per month. This represents approximately one-tenth the cost of present meter-reading methods.

sweepstakes

The prize drawings for the ham radio sweepstakes are taking place as this is being written. The grand prizes, a Signal/One transceiver and Delta Seventy linear amplifier, were won by W2ANB in Slingerlands, New York. W2CNB, W4YPC and WB8DUO are the proud new owners of Varitronics IC-2F fm transceivers. Fifty other winners will receive the famous RSGB "Radio Communications Handbook." We will have complete details in the September issue.

Jim Fisk, W1DTY
editor
DESCRIPTION:
Top Band Systems introduces the TBS-2000, a completely new concept linear amplifier with built-in transformerless 220VAC power supply. Top Band Systems' exclusive transformerless, grounded-grid, zero-biased design makes for a highly efficient, lightweight linear amplifier. Weighing but ten pounds, the TBS-2000 is an ideal companion for any transmitter or transceiver on six bands – 160 through 10 meters, including MARS. The TBS-2000 can be operated off a 110-125VAC source by simply plugging-in the accessory TBS-110 solid-state module. The TBS-2000 can also be operated mobile with the addition of the TBS-12 plug-in inverter. One knob, broad band tuning allows you to "set and forget" while operating across the band.

SPECIFICATIONS:
- **Band Coverage:** 160, 80, 40, 20, 15, and 10 meters
- **Input Power:** 1600 PEP on SSB, 1000 watts on CW
- **Driving Power:** 80-150 watts
- **Output Impedance:** 50 ohms nominally
- **Tube Complement:** six RCA 31LQ6
- **Plate Current Meter:** 0-2 amperes, 5% move.
- **Relative Output Indicator:** indicator light
- **Relay:** built-in antenna change over relay
- **Power Supply Regulation:** 3% key-up to key down
- **Power Supply Filter Capacity:** total of 550 mfd
- **Input Voltage:** 220-240VAC, 50/60 HZ standard 110-125VAC input with accessory TBS-110 module – 11-14VDC input with accessory TBS-12 inverter
- **Power Cord:** a generous ten foot power cord is provided
- **Polarity:** cord may be plugged into wall without regard to polarity
- **Color:** light gray cabinet with dark gray panel insert
- **Dimensions:** cabinet is 11.25" wide, 5.75" high, 8.75" deep
- **Weight:** net 10 lbs (4.6Kg); shipping weight 13 lbs (6 Kg)
- **Price:** TBS-2000 $229.00, TBS-110 $39.00; TBS-12 Price – To be announced.

Top Band Systems, Dept. 3, 5349 Abbeyfield St., Long Beach, CA 90815

More Details? CHECK-OFF Page 94
A complete discussion of frequency multiplier circuits, including vacuum tubes, bipolar transistors, field-effect transistors, diodes and integrated circuits.

Radio amateurs have used frequency multipliers in receivers and transmitters for many years. The octave relationship of the originally designated amateur high-frequency and vhf bands (1.75, 3.5, 7.0, 14.0, 28.0, 56.0, 112.0, and 224 MHz) made doublers very popular in the era before World War II. Also, since the time when crystal control was first introduced frequency multipliers have been needed because of the maximum frequency limit of piezoelectric crystals at any given state of the art. In the 1930s crystals were limited to fundamental-mode types; crystals above 15 MHz were generally not available to radio amateurs. Therefore, amateurs who wanted to use crystal control on 28 MHz used a doublet from 14 MHz or two doublers from 7 MHz.

Fig. 1. Vacuum-tube push-pull triple circuit.
Table 1. Vacuum-tube conduction angle for different frequency multiplication ratios.

<table>
<thead>
<tr>
<th>Harmonic number</th>
<th>Conduction angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>90°-120°</td>
</tr>
<tr>
<td>3</td>
<td>80°-120°</td>
</tr>
<tr>
<td>4</td>
<td>70°-90°</td>
</tr>
<tr>
<td>5</td>
<td>60°-72°</td>
</tr>
</tbody>
</table>

Today, 7th- or 9th-order overtone crystals are available for frequencies up to about 200 MHz. This makes frequency multiplication less imperative. However, variable crystal oscillators (VCO) work best with fundamental mode AT-cut crystals (generally available only up to about 22 MHz) so we still find frequency multipliers in use. Also, multiplying up from a frequency standard, generally in the 1 to 5 MHz region, is often required to make calibrations at higher frequencies.

Until 20 years ago vacuum tubes and point-contact diodes were the only devices available as frequency-multipliers. For this application the vacuum tube was usually operated in class C with the cutoff bias set so the conduction angle was considerably less than 180°. This type of frequency multiplier is covered in detail by Terman. The higher the multiplication factor, the narrower the conduction angle must be for best multiplication efficiency; this is shown in Table 1. Two variations of the vacuum-tube multiplier are available to improve performance; both use balanced tubes. The push-pull multiplier, Fig. 1, cancels out even harmonics so is useful as a 3-, 5- or 7-times multiplier. This circuit looks just like a push-pull class-C amplifier except that the cross-neutralization capacitors are removed since the output is on a different frequency than the input. The push-push multiplier, Fig. 2, cancels the fundamental and odd harmonics so is useful as a doubler, quadrupler, 6-times multiplier, etc. Anyone who worked the VHF bands in the 1950s will remember the multi-stage push-push and push-pull 6J6 multipliers.

Transistor multipliers

With the development of the bipolar transistor a new type of multiplier became available – perhaps two new types. The most obvious way to use a transistor as a multiplier is to rely on the nonlinear characteristic of the base-emitter diode. The transistor doubler circuit in Fig. 3 has pi-networks on both input and output.

Fig. 2. Vacuum-tube push-push doubler circuit.

Fig. 3. Bipolar-transistor 21- to 42-MHz doubler. L1 is 3 turns no. 516 Air Dux; L2 is 4 turns no. 416 Air Dux; L3 is 7 turns no. 416 Air Dux.
Since the circuit is a frequency doubler and a pi network is a lowpass network, it is necessary to add a fundamental trap consisting of L₃, C₄ and C₅. (If it were a tripler circuit it would be necessary to have both fundamental and second-harmonic traps.) If you use a bandpass coupling network such as a double-tuned circuit these traps may be eliminated. Such a circuit is shown in fig. 4. In fact, if you are not too fussy about the rejection of fundamental and unwanted adjacent harmonics the circuit of fig. 5 can be used. However, fig. 5 is best suited for doubling because frequency doubling gives the greatest spacing (percentage) of unwanted frequencies.

Since the transistor does not conduct current until the base-emitter junction is forward biased it is necessary to have at least a few tenths of a volt across this junction for appreciable multiplier action. For this reason, if the drive level is low, it is advisable to use a little dc forward bias to cause the transistor to conduct. However, forward bias and low drive voltage minimize the nonlinearity of the base-

L₁ 10 turns no. 18, ½" ID, 5/8" long

L₂ 3 turns no. 18, ½" ID, ½" long

L₃ 5 turns no. 18, ½" ID, ½" long, tap at 1¼ turn from ground

L₄ ½" wide copper trap, 2" long, spaced ½" from chassis, tapped ½" from ground

fig. 6. Three frequency doublers which use forward bias of the base-emitter junction because of low-level drive.

8 HP August 1971
fig. 8. Push-pull tripler circuit is shown in (A). Circuit in (B) is a push-push doubler.

emitter junction and decrease the transistor's effectiveness as a multiplier. A transistorized crystal oscillator and multiplier chain using forward-biased frequency couplers is shown in fig. 6; it was originally designed as a local-oscillator source for a 432-MHz converter. Of course, the base-emitter voltage required to forward-bias germanium transistors (as in fig. 3 through 6) is lower than that required for silicon transistors.

In a recent article on transistor multipliers W6AJF suggested a number of practical circuit innovations that make frequency multipliers more efficient. One point is to reduce the effect of base-to-collector capacitance. He suggests a couple of ways of doing this: adding a series trap from the base to ground tuned to the output frequency, or using a capacitive divider in the input tuned circuit, making sure that C2 is no larger than 10 ohms at the output frequency (see fig. 7B). W6AJF also suggests the use of a "grid-leak" arrangement to reduce danger of transistor breakdown where the

fig. 7. Improving multiplier efficiency: Input of circuit (A) uses a series trap tuned to the output frequency; circuit in (B) uses a large value at C2.

fig. 9. Complimentary transistor frequency multipliers. Push-pull tripler circuit in (A); push-push doubler circuit in (B).
drive voltage exceeds the maximum base-emitter reverse breakdown rating.

As with tubes, it is possible to use push-pull transistor multipliers for odd-harmonic generation and the push-push transistor multipliers for even-harmonic generation (circuits are shown in fig. 8). Unlike tubes, however, we can build complimentary circuits with transistors. Since both npn and pnp transistors are available it is possible to build both complimentary push-pull and complimentary push-push multipliers (typical circuits are shown in fig. 9).

Of course, you don’t have to use the common emitter-configuration in transistor multipliers; common-base circuits matching (finding pnp and npn transistors that have equal but opposite polarity characteristics) is desirable for the complimentary push-pull and push-push circuits. Dual npn and pnp silicon transistors are quite commonly available; also, many companies offer separate npn and pnp transistors which are intended for complimentary use (such as the Motorola 2N3903 and 2N3905). In the case of matched npn transistors it is often less expensive to buy an IC array, such as the

fig. 10. Complimentary common-base multiplier circuits. (A) is push-pull tripler; (B) is push-push doubler.

fig. 11. Broadband push-push frequency doubler circuit uses two transistors of a CA3018 IC; numbers indicate IC pin numbers. T1 is a North Hills 50:400-ohm balanced transformer. Ground pin 10 of the CA3018.

fig. 12. Broadband push-pull complimentary tripler circuit. Primary of T1 is 28 bifilar turns no. 30 on Indiana General CF103-Q1 core; secondary is 2 turns no. 24.
RCA CA3018, than to buy a commercial matched pair; the CA3018 contains 4 matched npn transistors (see fig. 11). A broadband complimentary bipolar tripler is shown in fig. 12.

parametric multiplication

A second mechanism that may be used for frequency multiplication with transistors uses the base-collector depletion capacitance. This is called parametric multiplication. As with parametric diode multipliers you must design carefully to obtain anything like optimum efficiency. The parametric effect is a high-level one and only becomes important when the rf voltage is swinging a significant percentage of the collector-to-base voltage. To make the most of the parametric effect the collector circuit must have a number of idler circuits which increase efficiency by reflecting undesired harmonics back to the collector-base capacitance. A typical parametric transistor multiplier for tripling from 333 to 999 MHz is shown in fig. 13.

fet multipliers

The field-effect transistor is a more recent addition to the amateur's bag of semiconductor tricks. Fets have dropped in price with the availability of plastic packaging and modern production methods, and a number of respectable devices are available for a dollar or less. Fets can be grouped into two general types: Junction and insulated-gate. Both n- and p-channel fets are available in junction and insulated-gate versions. The fet frequency multiplier can be treated in much the same way as the

*The broadband transformer used in fig. 11, as well as the one used in fig. 18, is available for $5.50 postpaid from Hank Olson, Post Office Box 339, Menlo Park, California 94025.

fig. 13. Uhf transistor parametric multiplier. RFC2 is 0.33-ohm wirewound resistor.

fig. 14. Simple fet frequency multiplier.
vacuum-tube multiplier, with cutoff bias applied to the gate and rf drive voltage to set the conduction angle indicated in table 1. Two such circuits are shown in fig. 14. Both of the fets in fig. 14 are n-channel devices since most fets for rf are n-channel types, whether junction or insulated-gate types.

Since both n- and p-channel fets are available it is possible to build the complimentary push-pull and push-push multipliers in much the same way as with bipolar transistors. Circuits are shown in fig. 15. Conventional push-pull and push-push multipliers are feasible too; examples are shown in fig. 16. Matched fet pairs are commonly available, and push-pull and push-push circuits will work best with them. A complete 14-MHz crystal oscillator and fet push-push doubler with 28 MHz output is shown in fig. 17. The 28-MHz output is remarkably free of 14 MHz energy due in part to circuit balance, and in part to the resonant circuit, T2. Another fet push-push doubler, one that will work over the entire high-frequency spectrum, is shown in fig. 18. A broad-band complimentary fet doubler is in fig. 19.

IC multipliers

Two similar devices that have recently been introduced to the IC market are the multiplier and the balanced modulator; either can serve as a frequency doubler. The Motorola MC1595 and MC1596, or their Fairchild equivalents, µA795 and µA796, can be used as doublers by introducing rf drive into both inputs. Since the MC1595 and µA795 are true multipliers the input signal is multiplied times itself, producing a \( \sin^2\theta \) waveform. The \( \sin^2\theta \) waveform looks very much like a full-wave rectified sine wave and contains only the second harmonic plus a dc component.*

The MC1596 and µA796 balanced modulators operate in much the same

*If you are accustomed to trigonometric identities, the following equation provides an explanation for multiplier operation:

\[
\sin^2\theta = \frac{1}{2}(1 - \cos 2\theta)
\]
Fet 14-MHz crystal oscillator and push-push doubler. Primary of T1 is 20 turns no. 26 on Amidon T44-6 toroid core; secondary is 4 turns no. 22, center-tapped. Primary of T2 is 13 turns no. 20, on Amidon T44-6 core; secondary is 2 turns no. 20. Fets Q2 and Q3 are selected for approximately equal Idss.

way as the IC multipliers although they are not true multipliers. Frequency-multiplier circuits for the MC1595 and MC1596 are shown in fig. 20. Note that the circuit of fig. 20A does not depend on tuned circuits to suppress undesired harmonics but does so by circuit balance alone.

diode multipliers

The point-contact diode has been used as a frequency multiplier since the first 1N34s became available, and possibly earlier than that. These diodes were

fig. 17. Fet 14-MHz crystal oscillator and push-push doubler. Primary of T1 is 20 turns no. 26 on Amidon T44-6 toroid core; secondary is 4 turns no. 22, center-tapped. Primary of T2 is 13 turns no. 20, on Amidon T44-6 core; secondary is 2 turns no. 20. Fets Q2 and Q3 are selected for approximately equal Idss.

fig. 18. Broadband fet push-push doubler. T1 is broadband push-push doubler. T1 is broadband North Hills 50:400-ohm balanced transformer. U257 is dual matched Siliconix fet.

fig. 19. Complimentary fet broadband push-push doubler. Primary of T1 is 28 turns no. 30 bifilar wound on Indiana General CF103-Q1 core; secondary is 2 turns no. 24.
usually used to enhance the harmonics of 100-kHz crystal calibrators, so they cannot be considered to be multipliers of any significant efficiency. Modern versions of such a calibrator would probably still use a 1N100 or 1N270 germanium point-contact diode since these are superior even to good silicon computer diodes.

The hot-carrier or Schottky-barrier diode, such as the Hewlett-Packard HP 5082-2800, is better than either the point-contact germanium or the silicon junction diode. If you use two matched hot-carrier diodes, arranged as a full-wave rectifier, a fairly efficient doubler can be built; a broadband doubler is shown in fig. 21. This circuit is very useful as a signal generator accessory.

In fact, broadband doublers are sold by Hewlett-Packard and other test equipment manufacturers for doubling the high-frequency output range of their signal generators. The diode doublers put out 12 to 16 dB less second harmonic than input.

Another diode frequency multiplier is the parametric diode multiplier. Many circuits have been published. Like the parametric transistor multiplier, which they pre-date, operation of the parametric diode multiplier relies on the...
variable capacitance of a reverse-biased junction. Idler circuits are required, and the design and tuneup procedures are extremely tedious. A typical 150 MHz to

![Diagram](image)

450 MHz diode parametric multiplier is shown in fig. 22. This single-ended design is the form most used in amateur equipment.

It is also possible to build a push-pull parametric multiplier which will have the same even-harmonic cancelling properties of the push-pull multipliers I’ve discussed previously (fig. 23). It follows, then, that a push-push parametric multiplier which cancels fundamental and odd harmonics could also be built. Such a circuit is shown in fig. 24.

A later development in the way of multiplier diodes is the step-recovery diode. Unlike the parametric diode or varactor, the step-recovery diode does not depend principally on the nonlinearity of its depletion capacitance for harmonic generation. Instead, it depends on the fact that when it is forward biased a charge is stored; when the diode is subsequently reverse biased the charge is dumped. In a properly designed circuit the step-recovery diode will be driven into forward conduction by positive excursions of the fundamental drive voltage; the stored charge will dump into a tuned circuit at the desired output frequency.

In a step-recovery frequency multiplier the harmonic power is proportional to $1/n$; where $n$ is the harmonic number. This is much better than the power falloff of a varactor multiplier where harmonic power is proportional to $1/n^2$. In a 144 MHz to 432 MHz tripler, for example, harmonic power would be 3 times greater with a step-recovery multiplier circuit. Fig. 25 shows efficiency vs harmonic number $n$ for a typical step-recovery diode multiplier. Note that large values of $n$ are quite feasible.

There’s another advantage, too: Only the desired output frequency is tuned in a step-recovery diode multiplier – no elaborate idler system is required. Until recently step-recovery diodes

![Diagram](image)

fig. 23. Balanced parametric diode 50- to 150-MHz tripler features conversion efficiency of 70%. L1 is 0.18 uH choke. L2 is 7 turns no. 18, 5/16" diameter, 3/4" long, center-tapped. L3 is 8 turns no. 20 closewound on 1/2-inch form.

fig. 24. 112.5- to 225-MHz balanced parametric diode doubler. Primary of T1 is 2 turns no. 16, 3/8" diameter, 1-1/2" long, center-tapped; secondary is 2½ turns no. 16 on each side of primary. Conversion efficiency is 75%. Varactors are TRW types.
have been very high-priced and available only to industry. However, one low-cost step-recovery diode is available for amateur experiments. The Siliconix

Note the similarity between step-recovery diode multipliers and parametric diode multipliers. The circuits are quite similar, so it is also possible to build

balanced step-recovery diode multipliers which cancel either odd or even harmonics. However, the advantages of balanced step-recovery diode multipliers is decreased because no idler circuits are eliminated.

phase-locked multipliers

In recent years another, a more complex method of frequency multiplication has been used for special purposes; this is the phase-locked loop frequency multiplier. Frequency synthesizers often make use of this technique because of its inherent signal cleanliness. The system effectively multiplies, but circuit operation is actually accomplished by frequency division. The general nature of the system is shown in fig. 27. To use this system you build the oscillator to the same frequency as the desired output, then phase lock it to a subharmonic. If

arrangement for a step-recovery diode frequency multiplier. With the Siliconix SV110 step-recovery diode conversion efficiency falls off as $\frac{200}{n}$ up to 3000 MHz so you can expect maximum efficiency of about 22% in a 144 MHz to 1296 MHz times-9 multiplier. To realize anywhere near this theoretical efficiency, however, circuit losses must be low.

*$5.50 from Siliconix Incorporated, 1140 West Evelyn Avenue, Sunnyvale, California 94086.
the oscillator is voltage-controlled the only input to it is the dc error voltage, so the output can be made nearly perfectly clean (since no rf is fed into the vco).

Since the phase-locked loop technique is rather complex it has been used only in expensive electronic systems. However, now the phase-locked loop has been tucked into an IC (or two). Because of the advance of IC technology it is a fairly simple matter to build a phase-locked loop frequency multiplier. Fig. 28 shows

a Signetics NE565 phase-locked loop with a divide-by-n counter; in this case a four-stage binary counter, the Signetics N8281. It is not necessary to use this particular counter as nearly any TTL counter or combination of flip-flops will do. Since flip-flops may be connected in a variety of ways to divide by nearly any number almost any harmonic can be multiplied by this system. The Signetics NE565 has an upper frequency limit of 500 kHz, but the Signetics NE562 may be used to 60 MHz as shown in fig. 29.

references
rf clipper
for the Collins S-line

This rf speech-processing circuit offers increased talk power without distortion or splatter — circuit can be adapted to other transmitters.

Rf speech clipping is the most effective technique for increasing the average to peak power output of a ssb transmitter without increasing the transmitted bandwidth or in-band distortion products. The high effectiveness of rf clipping was dramatically illustrated by W6JES. This article describes a highly effective rf speech clipper that is installed in a Collins 32S1 transmitter; the same circuit may also be used in the 32S3. The Collins S-line transmitter is one of the best rigs for added rf clipping circuitry because of

1. A beefy power supply, capable of supplying a high average current level.
2. The use of 6146 transmitting-type final-amplifier tubes coupled with an effective rf compression loop (alc) and negative feedback to the final amplifier stage for reduction of intermodulation products.
3. A stable, effective balanced modulator capable of providing carrier suppression in excess of 50 dB for long periods of time.

Because of the highly effective alc loop very little additional performance improvement is gained through the use of audio processing techniques such as compressors and audio clipper/filters. The apparent improvement noticed with these devices usually comes with a sacrifice in overall intelligibility because the noise power of the processor-generated distortion products increases nearly as much as the voice power. The net result is a sloppy signal of poor overall intelligibility — exactly the thing we are trying to improve by using a signal processing device.

Quantitatively, an overall improvement of about 1-dB is all you can expect from an audio processor without adding appreciable distortion. Any S-meter reports to the contrary are due to noise and distortion components of the processor that hang the slow decay agc of the receiver and cause a higher average meter reading.

rf clipping

The answer to the signal processor question, at least for the Collins S-line is rf speech clipping. With rf speech clipping all processing takes place at the 455-kHz i-f. All harmonic distortion components are multiplied in frequency and are no longer close to their audio fundamentals; therefore, they can be removed easily by a bandpass filter. Intermodulation distortion products are still present, but they don’t become objectionable at clipping levels up to 20 dB with the S-line transmitter.
clipper circuit

The rf-clipper circuit shown in fig. 1 is currently installed in my 32S1 transmitter. The circuit consists of an fet source follower, a variable gain IC amplifier, a transistor driver and diode clipper. The 2N5248 input stage matches the high output impedance of the 455-kHz mechanical filter to the IC amplifier. The variable-gain IC amplifier is based on the Plessey SL612C.* (A Motorola MC1590 IC should also work well in this circuit but one was not available when I built the clipper.)

The single transistor power-amplifier stage following the IC amplifier is necessary for maximum clipping level while providing enough surplus gain to allow the clipper to be taken in and out of operation by merely turning the gain control. The clipping diodes are connected across the collector circuit of this amplifier.

Several types of diodes were tried in this circuit including 1N914 silicon, 1N277 germanium and HP2800 hot-carrier diodes. As was expected at this frequency all types worked well. However, silicon devices have a higher conduction threshold in the forward direction, so require more clipper gain for a particular clipping level. The leakage of germanium diodes increases markedly with temperature, causing a noticeably lower level of clipping with a softness or rounding of the clipped peaks.

This leaves the hot-carrier diode as the best overall choice. The price of hot-carrier diodes is now less than $1.00 from your local Hewlett-Packard regional of-

---

C1 pF (Arco 403)
CR1 6.2-volt, ½-watt zener diode
CR2,CR3 Hot-carrier diodes, HP2800 (see text)
CR4 silicon rectifier

RFC1 7 turns no. 28 enameled on 0.060” diameter
RFC2 Ferroxcube 3K2A ferrite core
RFC3 5 mH (J. W. Miller 6304 or 70F-473A1)
U1 Plessey Microelectronics SL612C

fig. 1. Schematic for an rf signal clipper designed for the Collins S-line. Circuit can be adapted to other filter-type ssb transmitters which have sufficient power-supply reserve.

---

*The SL612C integrated circuit is $5.65 from Plessey Electronics Corporation, 170 Finn Court, Farmingdale, Long Island, New York 11735.
rice or from Hal Devices.* Matched pairs and quads are also available from both sources. However at 455 kHz, the characteristics of individual devices are close enough for very symmetrical clipping of the ssb envelope. A resistive attenuator across the output of the clipper reduces the output level to a suitable value for the 6DC6 i-f amplifier stage. The adjustable attenuator compensates for gain variations in the devices.

The alternative approach is to use the original filter in the sideband filter location, and use the second filter for crud rejection. The second filter may have considerably wider bandwidth than the sideband filter without causing any serious increase in distortion products.²

construction

My rf clipper is built on a 2x3-inch piece of copper-clad perforated Vector board. A Vector pad-cutting tool was used to insulate the holes needed for component mounting. Vector T-28 pins were used for component anchors and for circuit terminations to the power supply, input/output and gain-control pot.

The board is installed underneath the 32S1 chassis next to the existing mechanical filter. The wires for the remote gain control are routed through the PTO power cable hole to the pot which is mounted on an L-bracket at the rear of the PTO; the bracket is mounted with one of the PTO cover screws. The board is mounted with heavy no. 14 ground leads soldered to the copper-clad board; these leads are attached to solder lugs installed under existing screws in the immediate underchassis area.

adjustment

Adjustment of the rf clipper is simple if you have a monitorscope. If a monitoscop isn’t available, beg, borrow or steal one, at least for the initial setup. Using a single tone (32S1 in tune, then lock-key) tune and load the transmitter in the normal manner. Change the mode switch

---

*HAL Devices, Box 365H, Urbana, Illinois 61 801.
to either sideband and adjust the *mic* audio gain to the normal level. This should be between 8:30 and 10 o'clock, depending on the type of microphone you're using.

Change the *meter* switch to *alc* and check alc action. With the rf clipper turned off peaks should be between 4 and 8 dB. If required, adjust the output attenuator pot for this amount of average alc action. Now, advance the clipper gain control while talking; the slope of the scope pattern should change markedly, flattening out as shown in fig. 3. The average wattmeter reading will also increase. No flat-topping of the ssb speech envelope should be detected. Nor should the vertical scope deflection increase beyond the value first noted under single-tone conditions when tuning up with the *function* switch in *lock-key*. The alc level now should increase to 10 to 12 dB on peaks; if it goes above this level reduce audio gain or increase the value of the output attenuator until the correct alc levels are obtained.

**performance**

Performance of the rf clipper unit has been up to expectations. The results agree closely with those predicted in the *QST* article; that is, an improvement of 8 to 9 dB in signal intelligibility along with a 10- to 11-dB gain in average-to-PEP output-power ratio.

When using rf clipping, several precautions must be observed, especially with regard to the additional strain placed on final amplifier and driver due to the large increase in average input power. The resultant higher temperatures can have a detrimental effect on tube and component life, particularly in the area of the final amplifier compartment.

I eliminated part of the problem by substituting 7212/6146W tubes in the final. I also added a Rotron Whisperfan on top of the transmitter cabinet that blows cooling air downward through the box; the fan is simply mounted on rubber grommets and sits on the cabinet top. Power for the fan is obtained from the 516F2 power supply by tapping into the switched ac line. A small 2-pin Jones plug connects the fan power cord to a short 2-inch line coming out of the 516F2 power supply.

You may consider installing 6146B/8298A tubes in the final amplifier. However, the modification necessary to increase the screen voltage is not recommended with the clipper as the power supply and tube dissipation ratings will be grossly exceeded.

I feel that rf clipping is a must for optimum ssb talk power in any transmitter with sufficient reserve power supply capability. For example, this circuit can be adapted easily for use in transmitters using crystal filters such as the Heath SB400; only minor changes in the crystal filter impedance-matching circuits should be required. Use of the unit for about six months has resulted in a marked reduction of TCIP—“time calling in pileups.”

**references**

This efficient easy-to-tune grounded-grid 8877 amplifier can be run at 2000 watts PEP ssb or 1000 watts cw.

The new Eimac 8877 is a ceramic/metal high-mu triode rated for use up to 250 MHz. Operation of this tube at 50 MHz proved to be so satisfactory\(^1\) that other 8877 amplifiers have been designed and built for frequencies up to 350 MHz. Two of these amplifiers are of interest to the serious vhf operator. One amplifier is designed for the amateur 2-meter band and is described here. The other amplifier covers the range from 150 to 230 MHz, and is well suited for use on the amateur 220-MHz band; it will be described later.

The 8877 triode has good division between plate and grid current and low intermodulation distortion. It has a plate dissipation rating of 1500 watts and $\mu$ of approximately 200. The cathode is indirectly heated; filament requirements are 5.0 volts at 10 amperes. The tube base mates with a standard septar socket.

This 144-MHz 8877 linear amplifier is designed for the serious DXer who demands reliable service combined with...
good linearity and efficiency. The compact grounded-grid design presented here uses a half-wave plate line and a lumped T-network input circuit. The amplifier

requires no neutralization, is completely stable and free of parasitics, and is very easy to operate.

This amplifier is designed for continuous duty operation at the 1000-watt dc input level, and can develop 2000 watts PEP input for ssb operation with ample output. With the higher plate-voltage supply, up to 13.8-dB gain can be obtained with an amplifier efficiency of 62%.

the circuit

In the amplifier circuit in fig. 1 the 8877 grid is operated at dc ground. The
grid ring at the base of the tube provides a low-inductance path between the grid element and the chassis. Plate and grid currents are measured in the cathode-return lead; a 12-volt, 50-watt zener diode in series with the negative return lead; a 12-volt, 50-watt zener diode in series with the negative return path could burn open.

**input circuit**

The cathode input matching circuit is a T-network which matches a 50 ohm termination to the input impedance of the tube (about 54 ohms in parallel with 26 pF). The network consists of two series-connected inductors and a shunt capacitor. One inductor and the capacitor are variable so the network is able to cover a wide range of impedance transformations.

The variable inductor (L1) is mounted on the rear wall of the chassis and may be adjusted from the rear of the amplifier. The input tuning capacitor (C2) is adjustable from the front panel. When the network has been properly tuned no adjustment is required over the 4-MHz range of the 2-meter band.

Underchassis layout of components is shown in the photograph. The cathode input circuit is in center compartment.

**fig. 2.** Structural details of the amplifier show the relative size and position of the various components. Assembly is made of aluminum panels.

sets the desired value of idling current. Two additional diodes are shunted across the meter circuit to protect the instruments.

Standby plate current of the 8877 is reduced to a very low value by the 10,000-ohm cathode resistor; this resistor is shorted out when the vox circuit is energized, permitting the tube to operate in normal fashion.

A 200-ohm safety resistor insures that the negative power circuit of the amplifier does not rise above ground potential if the positive side of the plate-voltage supply is accidentally grounded. A second safety resistor across the 1N3311 zener diode prevents the cathode potential from rising if the zener should accidental-
The slug-tuned coil in the input matching circuit is mounted on the rear wall. Air-wound filament chokes are placed in front of the socket. The cathode-heater rf choke is near the top edge of the enclosure. All of the cathode leads of the mechanism are placed in the area between inclosure and panel.

plate circuit

The plate circuit of the amplifier is a transmission-line type resonator. The line

socket, plus one heater pin (pin 5) are connected in parallel and driven by the input matching network.

The ceramic socket for the 8877 is mounted one-half inch below chassis level by spacers. Four pieces of brass shim stock (or beryllium copper) are formed into grounding clips to make contact to the control grid ring. The clips are mounted between the spacers and the chassis. The aluminum clamps holding ends of plate lines are visible in the side compartments. The filament transformer and dial (L5 plus L6) is one half-wavelength long with the tube placed at the center (fig. 2). This type of tuned circuit has several advantages. A quarter-wave circuit would normally be preferred because of its greater bandwidth, but I wanted to use easily obtainable standard copper water pipe as the center conductor of the transmissionline tank circuit. The resulting high-impedance transmission line would make a quarter-wave plate tank circuit physically short and difficult to handle.
In addition, the heavy rf current that flows on the tube seals and control grid would, in the process of charging up the output capacitance to the plate voltage this type of cavity is complex and difficult to build.

A practical compromise is to use two quarter-wave lines connecting to opposite sides of the tube. It is interesting to note that each of the two quarter-wave lines is physically longer than if only one quart-

![fig. 3. Variable plate portion of plate-tuning capacitor C3. This arrangement permits the capacitor to be adjusted under full power without "jumpy" tuning as there are no moving or sliding contacts which carry heavy rf current.](image)

swing, tend to concentrate on one side of the tube if a single-ended quarter-wave circuit were used. This current concentra-

sion would cause localized heating of the tube. The best tuned circuit configuration to minimize this effect is a symmetrical cylindrical coaxial cavity. Unfortunately,

![fig. 4. Details of plate lines L5 and L6. Copper tubes are standard copper water pipe.](image)

ter-wave line were used. This is because only one-half of the tube output capacitance loads each of the two lines.

Resonance is established by a moving
plate capacitor (C5); antenna loading is accomplished by a second capacitor (C6) placed at the anode of the 8877. Output power is coupled from the plate circuit through the series capacitor into a 50-ohm output. In the top-view photo tuning capacitor C5 is at the front of the compartment; variable loading capacitor C6 is at the rear. The plate choke is visible in the front corner.

construction

The two-meter amplifier is built in an enclosure measuring 10¾ x 12 x 6¼ inches. The 8877 socket is centered on a 6 x 6 subchassis plate. A centrifugal blower forces cooling air into the underchassis area; the air escapes through the 2-5/8-inch diameter socket hole.

The plate tuning mechanism is shown in fig. 3. This simple apparatus will operate with any variable plate capacitor, providing a back and forth movement of about one inch. It is driven by a counter

dial and provides a quick inexpensive and easy means of driving a vhf capacitor. The ground return path for the grounded capacitor plate is through a wide low-

inductance beryllium-copper or brass shim stock which provides spring tension for the drive mechanism.

The variable output coupling capacitor is located at the side of the 8877 anode. The type-N coaxial fitting is connected to the moveable plate of the coupling capacitor. The fitting is centered in a special tubular assembly which allows the whole connector to slide in and out of the chassis, allowing the variable plate of the coupling capacitor to move with respect to the fixed plate mounted on the tube anode clamp. When the final loading adjustment has been set the sliding fitting is clamped by an arrangement similar to the slider on a variable wire-wound resistor.

The length of the plate-line inductors (L5 and L6) is adjusted by means of dural blocks placed at the shorted end of the line (fig. 4). The position of the blocks is determined by setting capacitor C5 at its lowest value and adjusting line lengths so that that plate circuit resonates at 148 MHz with the 8877 in the socket.

The plate rf choke is mounted between the junction of one plate strap and a pair of the dual blocking capacitors; the high-voltage feed-through capacitor is mounted to the front wall of the plate compartment. The blocking capacitors are rated for rf service, and inexpensive tv-type capacitors are not recommended for this amplifier. A short chimney to
direct cooling air from the socket through the anode of the 8877 is made from Teflon and clamped between the chassis deck and the anode strap.*

**operation**

Amplifier operation is completely stable with no parasites. The unit tunes up exactly as if it were on the “dc bands.” As with all grounded-grid amplifiers excitation should never be applied when plate voltage is removed from the amplifier.

The first step is to grid-dip the input and output circuits to near-resonance with the 8877 in the socket. A swr meter should be placed in series with the input line so the input network may be adjusted for lowest swr.

Tuning and loading follows the same sequence as any standard grounded-grid amplifier. Connect a swr indicator at the output and apply a small amount of rf drive. Quickly tune the plate circuit to resonance. The cathode circuit should now be resonated. The swr between the exciter and the amplifier will not necessarily be optimum. Final adjustment of the cathode circuit for minimum swr should be done at full power because the input impedance of a cathode-driven amplifier is a function of the plate current of the tube.

Increase the rf drive in small increments along with output coupling until the desired power level is reached. By adjusting the drive and loading together it will be possible to attain the operating conditions given in the performance chart in table 1. Always tune for maximum plate efficiency: maximum output power for minimum input power. It is quite easy to load heavily and underdrive to get the desired power input but power output will be down if this is done.

I would like to thank K6DC for his help in adjusting and determining the operating conditions for this two-meter amplifier.

**table 1. Performance data for the 144-MHz power amplifier under the conditions most suitable for amateur ssb (2000 watts PEP) and cw (1000 watts).**

<table>
<thead>
<tr>
<th>Plate voltage</th>
<th>3000 V</th>
<th>2500 V</th>
<th>2500 V</th>
<th>2500 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate current (single tone)</td>
<td>667 mA</td>
<td>800 mA</td>
<td>400 mA</td>
<td>400 mA</td>
</tr>
<tr>
<td>Plate current (idling)</td>
<td>54 mA</td>
<td>44 mA</td>
<td>44 mA</td>
<td>44 mA</td>
</tr>
<tr>
<td>Grid voltage</td>
<td>-12 V</td>
<td>-12 V</td>
<td>-12 V</td>
<td>-12 V</td>
</tr>
<tr>
<td>Grid current (single tone)</td>
<td>46 mA</td>
<td>50 mA</td>
<td>28 mA</td>
<td>28 mA</td>
</tr>
<tr>
<td>Power input</td>
<td>2000 W</td>
<td>2000 W</td>
<td>1000 W</td>
<td>1000 W</td>
</tr>
<tr>
<td>Power output</td>
<td>1240 W</td>
<td>1230 W</td>
<td>680 W</td>
<td>680 W</td>
</tr>
<tr>
<td>Efficiency (apparent)</td>
<td>62 %</td>
<td>62 %</td>
<td>68 %</td>
<td>68 %</td>
</tr>
<tr>
<td>Drive power</td>
<td>47 W</td>
<td>67 W</td>
<td>19 W</td>
<td>19 W</td>
</tr>
<tr>
<td>Power gain</td>
<td>13.8 dB</td>
<td>12.6 dB</td>
<td>15.5 dB</td>
<td>15.5 dB</td>
</tr>
</tbody>
</table>

I would like to thank K6DC for his help in adjusting and determining the operating conditions for this two-meter amplifier.

**references**


*Detailed drawings of the anode clamp, plate resonator and blocking capacitor assembly, and variable plate tuning capacitor (C5) are available from R. Sutherland, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070. Ask for drawing numbers 168658, 168648 and 168647.
vhf fm channel scanner

With this low-cost solid-state fm channel scanner you can monitor up to four vhf fm channels at one time

Fixed-frequency amateur operation has become very popular during the last few years. One reason is the availability of commercial fm gear which can be converted easily to the vhf amateur bands. When using this equipment it's customary to pick a popular channel and monitor it for activity. This has the advantage that at any one time there will usually be a large number of local hams listening to the channel; to establish contact it is only necessary to give a short call.

While this type of fm operation may seem ideal it presents some problems. For example, a channel that is popular in one area may not be popular in another area. A mobile operator who is active on one channel has little chance of making contacts in another area where another channel is normally used. Furthermore, a channel which is popular one month may not be in vogue next month. Also, in a particular area you may find fm activity on a number of different channels. Without a large number of receivers, or a channel scanner, it's practically impossible to keep track of all the activity.

The four channel scanner described here can be used to monitor up to four channels in sequence. The scanner looks at each channel individually for 100 milliseconds. If there is no activity the scanner goes on to the next channel. This process continues until activity is encountered, at which time the scanner locks onto the active channel. It remains
table 1. Parts list for CS-4 channel scanner.

<table>
<thead>
<tr>
<th>qty</th>
<th>item</th>
<th>price</th>
<th>source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>printed-circuit board</td>
<td>$3.50 (undrilled) 4.50 (drilled)</td>
<td>Alton Industries, 7471 Thunderbird Rd., Liverpool, New York 13088</td>
</tr>
<tr>
<td>1</td>
<td>SN7473 IC</td>
<td>1.00</td>
<td>Gateway Electronics, 6150 Delmar Blvd., St. Louis, Mo. 63112</td>
</tr>
<tr>
<td>1</td>
<td>SN7400 IC</td>
<td>.50</td>
<td>same as SN7473</td>
</tr>
<tr>
<td>1</td>
<td>unijunction transistor</td>
<td>.30</td>
<td>Radio Shack,</td>
</tr>
<tr>
<td>1</td>
<td>2N3819 fet</td>
<td>.50</td>
<td>Poly Paks, P. O. Box 942, South Lynnfield Mass. 01940, 2 for $1.00</td>
</tr>
<tr>
<td>10</td>
<td>npn small-signal silicon transistors</td>
<td>2.38</td>
<td>Radio Shack, 15 for $1.19</td>
</tr>
<tr>
<td>4</td>
<td>2N3641</td>
<td>1.19</td>
<td>Radio Shack, 4 for $1.19</td>
</tr>
<tr>
<td>5</td>
<td>small-signal silicon diodes</td>
<td>.02</td>
<td>Poly Paks, 40 for $1.00</td>
</tr>
<tr>
<td>24</td>
<td>resistors</td>
<td>2.40</td>
<td>Radio Shack, etc.</td>
</tr>
<tr>
<td>1</td>
<td>2-μF capacitor</td>
<td>.40</td>
<td>Radio Shack, etc.</td>
</tr>
<tr>
<td>1</td>
<td>150-μF capacitor</td>
<td>.60</td>
<td>Radio Shack, etc.</td>
</tr>
</tbody>
</table>

$12.79

locked on the active channel until manually released, or activity stops.

When designing the scanner I wanted to develop a reliable unit which could be built easily at low cost. These goals have been met; the scanner can be built for less than $13 if all parts, including the printed-circuit board, are purchased new. The unit can be completely assembled in 3 or 4 hours. In addition, the channel scanner, which I call the CS-4, can be connected to many of the fm transceivers on the market without making major modifications.

fig. 1. (Left) Vhf fm channel scanner. Lamps are 6, 12 or 24-volt, 200 mA maximum; voltage $V_L$ is proper voltage for selected indicator lamps.

Q2,Q4,Q5,Q7, npn small-signal transistor Q8,Q10,Q11, (Radio Shack 276B590)
Q13,Q14,Q16

Q3 unijunction transistor (Radio Shack 276B111)

R1 optional 2-meg resistor (see text)

U1,U2 part of Texas Instruments SN7473 dual J-K flip-flop

U3 Texas Instruments SN7400 quad dual-input gate

fig. 2. Typical waveforms of the channel scanner.
The CS-4 is built around two inexpensive integrated circuits: the Texas Instruments SN7473 dual JK flip-flop and SN7400 quad dual-input AND gate. The dual JK flip-flop counts to four using two binary bits for the count. The quad dual-input gate separates the counts of the two binary bits into four separate outputs. The four separate outputs drive discrete transistors which in turn drive the lamps and the diode or transistor switches for each channel. Lamp drivers and diode or oscillator drivers must be used since the SN7400 will not handle the required voltage or current. Although an additional IC could have been used, one designed for output driving, discrete components were chosen to keep cost to a minimum.

Since the scanner is built around a counting circuit it's necessary to provide a source of pulses to be counted. A variety of circuits were tried, and most of them worked well; the unijunction circuit as shown in fig. 1 proved to be the least expensive. With the components specified the scanning rate is about 100 ms per channel. This rate seems adequate. However, if you want a different scanning rate the 2 μF capacitor may be changed; lowering the value will increase the scanning rate. If the scanning rate is too fast, however, the scanner will not lock since signal detection in the receiver may not occur rapidly enough.

The output of the unijunction clock circuit is fed into an npn transistor operating in the saturated mode. This transistor produces a large-amplitude negative-going pulse. The large negative-going pulse drives the flip-flops.

The channel-locking circuit was the result of considerable experimentation. Several problems were encountered: first was the problem of stopping the oscillator quickly; the second was how to get the receiver to stop it. One of the first approaches used an npn transistor with the emitter grounded and the collector connected directly to the emitter of the unijunction. A positive voltage caused the transistor to conduct, shorting the
emitter of the unijunction to ground, stopping the oscillator. However, this circuit had too much lag.

With scanning rates less than one channel per second the lock circuit did not react fast enough, so the scanner never locked. Although one channel per second may sound like a reasonable rate, it resulted in parts of a transmission being missed before lock occurred. This problem was corrected by using a small silicon diode, CR1, to isolate the emitter of the unijunction from Q2. This transistor switches the unijunction emitter from ground to +15 volts.

Solving the problem of locking the receiver turned out to be fairly simple. It was only necessary to find a point in the receiver that had a marked voltage change between signal and no-signal. Two points used successfully were the grid of the first limiter and the derived squelch-voltage output. It is preferable to use the squelch-voltage output since it is immune to noise. The first limiter voltage fluctuates with noise and will cause the scanner to lock in the presence of noise; this can be quite annoying.

Although the input locking circuit in fig. 1 is designed to operate with a tube-type receiver that has a squelch voltage that ranges from slightly positive to several volts negative (with signal) the scanner can also be used with transistorized rigs that have positive squelch voltage or current.

construction

Construction of the scanner is simplified if you use the commercially-available printed-circuit board.* If you use the components shown in the table the scanner can be built for less than $13. The npn transistors are not critical and virtually any small signal silicon types in your junk box will work. The integrated circuits are not critical either. The only criteria is that they be of the TTL variety, designed for a 5-volt power supply. If other ICs are used it will probably not be possible to use the commercial printed-circuit board since the pin connections will probably be different.

I recommend that you build one stage at a time and check it out before going further. With this step-by-step construction procedure it is easy to uncover possible problems. The unijunction oscillator stage should be built first. This circuit can be checked with an oscilloscope. The waveforms in fig. 2 will help if you run into problems. If you don't have these waveforms check to see that all parts are wired correctly; then try parts substitution.

After the oscillator is working properly build the locking stages, Q1 and Q2. When a negative voltage of several volts is applied to the input of Q1 the oscillator should stop. Since the gate of Q1 will hold a charge for some time it may be

*Printed-circuit boards are available from Alton Industries, 7471 Thunderbird Road, Liverpool, New York 13088. Drilled boards are $4.50; undrilled boards, $3.50. Completely wired and tested channel scanners are $33.50.
necessary to wire an external 2.2 meg resistor from the squelch input to ground when testing the unit on the bench. After the locking stages are working the remaining portions of the scanner can be built. The waveforms in fig. 2 should help in diagnosing any problems.

**installation**

The scanner installation at my station is shown in fig. 3. This circuit permits either manual or automatic operation by merely throwing a switch.

The squelch input to the scanner can be obtained from a typical tube-type transceiver as shown in fig. 4. If this is not possible the scanner squelch input should be connected to the grid of the first limiter stage. The 2-megohm resistor from the gate of Q1 is needed only if the scanner lock signal is taken from the first limiter.

If the fm receiver is a transistorized unit that does not have a voltage that goes from zero to at least 2 volts negative, the scanner must be modified slightly. Using a vtm, find a spot in the receiver squelch circuit which shows a marked voltage change with the presence of a signal. If the voltage goes from zero to positive from no signal to signal, apply this voltage directly to the base of Q2 through an isolation resistor (fig. 5).

If the voltage goes from positive to zero from no signal to signal, then the input to the scanner should be modified as shown in fig. 6. In this case, Q1 is replaced by a junkbox npn silicon bipolar. The isolation resistor R1 is determined experimentally by selecting a value which will lock the scanner, but not affect receiver operation.

---

**fig. 6. Channel scanner modification for use with solid-state fm receiver where signal voltage goes from positive to zero with signal. The fet input stage is replaced with an npn small-signal transistor. For value of isolation resistor R1 see text.**

---

To connect the scanner to the oscillator stages in the fm receiver the circuits must be modified slightly. One of the oscillator circuit modifications in fig. 7 should work with your receiver.

Two supply voltages are required for the scanner, +5 volts and +15 volts (nominal). The +5-volt supply is critical...
and should be obtained from a regulated source. The nominal +15 volts may be anywhere from 12 to 18 volts.

**using the scanner**

To start scanning, all channel switches should be on, the scan-auto switch should be to scan and the delay switch to out. The channel scanner should begin scanning immediately. As soon as a signal appears on one of the four channels the scanner will lock. With the delay switch out, the scanner will start scanning again as soon as the signal on the channel disappears. In this mode you can keep track of activity on other channels during transmission breaks.

If you want to monitor both sides of a QSO turn the delay switch on. In this mode the scanner will remain on a given channel for several seconds after the activity ceases. This prevents switching and locking on another active channel during transmission breaks.

With the delay switch out the scanner will resume scanning for one scan if the release button is pressed when the scanner is locked to a channel. To transmit the scanner lock switch must be on. This locks the scanner on the active channel and the push-to-talk line is connected to the mike. You can get the same results by switching to manual. The manual position is used so that more than four channels may be used. At my station the transmit and receive oscillators for a given channel are tied to a single control line. When the scanner locks I am ready to transmit after setting the lock switch. By running the push-to-talk line through this switch the transmitter cannot be activated while scanning. If you operate the scanner while transmitting you'll get 100-ms pulsed signals on four channels.

**summary**

The CS-4 channel scanner was designed to provide a simple, low-cost FM scanner that could be installed with little difficulty. Many of these units are now in operation in central New York State with excellent results.

**ham radio**
A dual-stub system providing 32-dB attenuation at the design center frequency and more than 25-dB attenuation for a 1% frequency change

More often than not, a good vhf receiving system is determined not by what it receives, but by what it rejects. The congestion of radar, radio positioning, and mobile services near amateur vhf bands often leads to distressing image problems. Many low-noise, transistorized receiving systems can be rendered near-useless because of a strong image signal from a station far removed from the amateur band.

On the other hand, spurious signals from improperly adjusted or poorly designed amateur transmitters can, and do, cause interference to other vhf services. Unwanted signals are everybody's problem. Such signals in the coaxial transmission line can be attenuated more than 30 dB by using dual stubs, one for unwanted signal rejection and the other to correct line impedance. These stubs are well worth trying, as they are inexpensive and they work! When interference is confined to a discrete range of frequencies, this high-Q coaxial filter will do an outstanding job of interference rejection.

the dual coaxial filter

The dual coaxial filter is shown in fig. 1. It works well between 20 — 250 MHz and has often been used in commercial mobile and point-to-point equipments. Two stubs are used. One, $l_1$, is for signal rejection at the unwanted frequency; and another, $l_2$, is for impedance correction at the operating frequency.

The stubs are made from lengths of coaxial line. For low power (under 100
watts) and for receiving systems, RG-58A/U may be used. Transmitting systems should use the heavier RG-8A/U line. These two lengths of coaxial line, \( l_1 \) and \( l_2 \), properly adjusted, provide good filtering as shown by the unwanted-signal rejection plot of fig. 2. For a frequency change from the design frequency of one percent (1.4 MHz at 144 MHz), the dual filter offers better than 25-dB rejection to the unwanted signal. Tuned "on the nose," filter rejection is somewhat better than 32 dB.

**operation**

The rejection stub, \( l_1 \), is an electrical half wavelength at the rejection frequency. The impedance-correction-stub length, \( l_2 \), may vary from near-zero to an approximate electrical half wavelength at the operating frequency, as discussed later. Both stubs are placed in parallel across the coaxial transmission line at one point (preferably near the equipment) and are shorted at the far ends.

Since the rejection stub is one-half wavelength at the rejection frequency, its impedance across the coaxial line at this frequency is close to zero, effectively bypassing this frequency to ground. However, at the operating frequency, the rejection stub is not a shorted half-wavelength section and therefore presents either capacitive or inductive reactance to the transmission line. The unwanted reactance is compensated by adding the impedance-correction stub, which presents an equal and opposite reactance at the operating frequency.

The length of both stubs depends upon the operating frequency and the relationship between this frequency and the rejection frequency, as illustrated in fig. 3. For example, assume the operating frequency, \( f_0 \), is 146 MHz and the rejection frequency, \( f_r \), is 118 MHz, a not uncommon relationship. The ratio 118/146 is 0.81\( f \). This falls on the x-axis of the lower chart between 0.75\( f \) and 1\( f \). The curve shows that, in this example, the reactance presented by the rejection stub to the line is inductive; and the upper curve shows that the impedance-
correction stub should present a capacitive reactance at the operating frequency, thus balancing the effect of the rejection stub at the operating frequency.

**adjustment**

Shown in fig. 4 are approximate lengths for the stubs, as computed for solid dielectric cable having a velocity factor of 0.66. For the example, the rejection stub, $l_1$, is an electrical half wavelength at the rejection frequency of 118 MHz, or a little less than 40 inches long. A length of line a few inches longer than this should be connected across the transmission line as shown in fig. 1. The stub may be adjusted to the rejection frequency with a grid-dip oscillator by placing a small loop at the unshorted end and trimming the shorted end for resonance.

Even easier, a signal at the unwanted frequency may be injected into the existing transmission line. Using a needle, the inner conductor of the stub is shorted to the outer conductor at various points, starting from the end of the stub and working toward the transmission line. The short is advanced about one-half inch at a time until the position of greatest attenuation of the unwanted signal is found. The line is permanently shorted at this point. This is best done by removing a short slug of the inner insulation and collapsing the outer shield around the center conductor and soldering it all around.

The impedance-correction stub, $l_2$, is now added. For various ratios of rejec-
tion-to-operating frequency, the length of this stub may vary from near-zero to about one-half wavelength. For an operating frequency of 146 MHz, a quarter wavelength in the coaxial stub is about 17 inches or less. If this stub were this length, it would present a very high impedance to the desired signal. However, according to fig. 3, the correction stub should present a capacitive reactance and must therefore be longer than one-quarter wavelength. As a starter, the stub is cut to one-half wavelength and progressively shorted with a needle as outlined for the rejection stub. In this case, however, tuning is done to produce the least attenuation of the desired signal; or in the case of the transmitting stub, the least value of SWR on the transmission line.

filter limitations

If the rejection frequency happens to be 1/2, 1/4, or 1/8 the operating frequency, the dual-stub filter cannot be used, as the rejection stub will be a full wave-length (or multiple thereof) at the operating frequency and will, therefore, present a near-short to the operating frequency as well as to the rejection frequency. On the other hand, if the undesired frequency happens to be twice or 3/4 the operating frequency, a correction stub will not be necessary since the rejection stub will be a quarter wavelength (or three-quarter wavelengths) at the operating frequency and will present a high impedance at this point.

construction

As any wise vhf enthusiast knows, rf has a disconcerting habit of running wild and free in the vhf spectrum. Unless properly contained, the unwanted signals can pass freely around the dual coaxial filter, rendering it useless. This means that no antenna currents should flow on the outer surface of the shield of the coaxial line and the shield should not be broken at the junction of the filters and line. The best way of attaching the two coaxial stubs to the transmission line, therefore, is to make up a small box of brass stock and mount a coaxial hood on the box for each cable, as shown in fig. 5. This makes an rf tight enclosure and helps keep the rf where it belongs.

references


ham radio

Dear Zambo Electronic Parts Cleaner Co.—

"I like Zambo cleaner because..."
A function generator is a specialized signal generator normally used for testing complex electronic equipment; output signals include sine, cosine, square and triangular waveforms. As you might imagine, the electronic components necessary to generate this array of waveforms is rather complex. However, there is now an integrated circuit available that generates both square and triangular waves.

The new Signetics NE566 IC is a voltage-controlled oscillator that produces a highly accurate square wave and a very linear triangular wave up to 1 MHz. It can be used in tone generators, frequency-shift keyers, FM modulators, clock generators and signal generators. The output frequency is extremely stable.

The Signetics NE566 function-generator IC contains 21 transistors, 10 diodes and 16 resistors.

Jim Fisk, W1DZY, editor
fig. 1. Basic function generator using the Signetics NE566T. Frequency is determined by R1, C1, and the bias voltage on pin 5.

voltage supply at pin 8, must be greater than 0.75 volt, but less than the positive supply (24 volts maximum). In fig. 1 the control voltage is set by the voltage-divider resistors, R2 and R3.

Output frequency vs control voltage is plotted in fig. 2. Normalized frequency is used on the vertical scale to provide maximum usefulness. This means simply, that, if the oscillator frequency is 1000 Hz (with 1.5 volts bias), with 3 volts bias the output frequency will be approximately 1800 Hz. As you can see from this graph the integrated circuit can be modulated by the control voltage over a wide range with excellent linearity. A modu-
lating signal can be ac coupled to the device through capacitor C2 in fig. 1.

Resistor R1 and capacitor C1 also determine output frequency. By proper selection of these two components the frequency may be set at any point up to 1 MHz. Once set, frequency drift is negligible at room temperature. Resistor R1 should be in the range between 2000 and 20k ohms. Its affect on output frequency is plotted in fig. 3. Note that normalized frequency is again used in this graph, with a normalized value of 1.0 when R1 = 10k. The value of C1 vs frequency is shown in fig. 4; this graph is based on 10k resistance at R1.

To show the use of figs. 3 and 4 let’s choose values for R1 and C1 that will provide an output of 3000 Hz. First go to fig. 4 – 3000 Hz coincides with about 0.007 μF capacitance, a rather unordinary value. Choose the closest standard value, 0.01 μF. This moves the frequency down to about 2200 Hz.

If you read the fine print in the caption of fig. 4 you’ll see that this capacitor is based on a 10k resistance at R1. To bring the frequency up to 3000 Hz use a slightly lower resistance as shown in fig. 3. To find the necessary multiplication factor, divide 2200 into 3000; this gives a factor of 1.35. Entering fig. 3 at 1.35 on the normalized frequency scale you find the required resistance value to set the output frequency at 3000 Hz; approximately 8000 ohms.

practical circuits

If the output frequency is off slightly when you build the circuit, you can add parallel trimming resistors to set the

output frequency exactly. Or, if you want a variable frequency output, you can replace R1 with a potentiometer. A typical circuit is shown in Fig. 5. In this circuit capacitor C1 is selected by switch S1. Five capacitors will provide nearly complete coverage form about 20 Hz to 1 MHz.

When building this unit be sure to include the 0.001 capacitor between pins 5 and 6 of the integrated circuit (with short leads). This prevents oscillation of the internal IC circuits.

The NE566T is a natural choice for driving standard IC logic circuitry. If you use the dual ±5-volt power supply as in fig. 6 the square-wave output will have the proper dc level for driving directly RTL logic. For DTL or TTL logic connect a 5000-ohm resistor between pin 3 and the negative supply voltage.

ham radio

fig. 6. Plus and minus supply voltages put the square wave output at the proper dc level for driving logic circuitry. RTL logic may be driven directly; DTL and TTL logic require 5000-ohm resistor connected to the negative supply.
BONUS
THE BEST ANTENNA PACKAGES YET!
OPTIMUM PERFORMANCE GUARANTEED SAVINGS


Local Bank Financing - 15% Down or Trade-In Down - Good Reconditioned Equipment. Nearly all makes and models. Our reconditioned equipment carries a 30 day warranty and may be traded back within 90 days for full credit toward the purchase of NEW equipment. Inquiries invited.

"CERTIFIED WELDERS & APPROVED BY L.A. CITY"

LAE MW35 "STANDARD" Package
(Free Standing Crank-Up Tower
9.5 Sq. Ft. - 50 MPH)
CDR AR-22R Rotator
100 ft. RG-58A/U Coax
100 ft. 4 Cond. rotor cable
Complete with one of the following antennas:
HY-GAIN TH2MK3 $259
HY-GAIN TH3JR $259
HY-GAIN DB10-15A $265
HY-GAIN HY QUAD $280
HY-GAIN TH3MK3 $290
*TR-44 rotor w/cable add: $ 30
HAM-M rotor w/cable add: $ 60

LAE W51 "DELUXE" Antenna Package
(Free Standing, 9 Sq. Ft. - 50 MPH)
CDR TR-44 rotor
100 ft. RG58A/U coax cable
100 ft. control cable
Complete with one of the following antennas:
HY-GAIN DB10-15A $575
HY-GAIN HY QUAD $590
HY-GAIN 204BA $610
HY-GAIN TH3MK3 $610
HY-GAIN TH6DXX $635
Free stdg. base incld. NO/CHARGE
*HAM-M rotor w/RG8/U add: $ 40

LAE LM354 "SUPER" Antenna Package
(16 Sq. Ft. - 60 MPH)
CDR HAM-M Rotor
100 ft. RGB/U coax cable
100 ft. control cable
Complete with one of the following antennas:
HY-GAIN TH3MK3 $735
HY-GAIN 204BA $740
HY-GAIN TH6DXX $765
Freight PREPAID to your door in the Continental USA west of the Rockies. For shipment east of the Rockies, add $10.00. Substitutions may be made... write for prices.

"WEST COAST'S FASTEST GROWING AMATEUR RADIO DISTRIBUTOR"
"WE SELL ONLY THE BEST"

Electronix Sales
23044 S. CRENSHAW BLVD., TORRANCE, CALIF. 90505
Phone: (213) 534-4456 or (213) 534-4402
HOME of LA AMATEUR RADIO SALES

More Details? CHECK-OFF Page 94
low-cost
instant
printed-circuit boards

Here's a simple technique for building printed-circuit boards for all your experimental projects.

The construction of electronic gear on a printed-circuit board presents a problem if a printed-circuit layout is not available. Breadboard assemblies for test prior to printed-circuit production, or one-time projects are examples of construction where it's hard to justify building a single printed circuit.

Instant tie points can solve most of these problems. By cutting a small ring through the copper surface of the copper-clad circuit board a small disc of copper remains which is firmly attached to the board but is electrically insulated from the rest of the sheet. These insulated discs make excellent tie points for connecting two or more component leads together. The tie points are very strong and, therefore, well suited for mounting components that can be supported with their own leads. Transistors, resistors, fixed or variable capacitors, inductors, crystal sockets, wire leads to external components and many other items can be soldered to these insulated discs. For example, three insulated discs, grouped close together, provide an excellent mounting base for a transistor and resistor, capacitor or other component. Terminals or pigtails that connect to ground are soldered to the copper surface of the circuit board without cutting a circular groove.
The cutting tool

The best part of this construction technique is that the saw that cuts the ring in the copper surface can easily be made at home. Several different sizes, for producing large or small insulated discs, are handy. However, a description of the saw I use most often will serve as a guide for making other sizes.

A 2- or 3-inch length of mild steel rod, 1/4-inch in diameter, is the only material required. If necessary, true up one end of the rod by turning it in a lathe. If a lathe is not available, careful work with a hand file is an acceptable substitute. Bore a shallow hole in the end of the rod using a number 3 drill. This forms a cup in the end of the rod with a narrow rim. Now make two hacksaw cuts across the face of the cup, 90 degrees apart. File away the metal between adjacent saw cuts on a slant to form saw teeth; be sure the slant is in the direction that results in the cutting edge of each tooth being headed in the right direction when the tool is rotated in a drill press.

To use the cutting tool, chuck it in a drill press. Center the saw over the spot on the circuit board where the tie point is required. Cut through the copper surface and slightly into the insulating material of the board. Practice using the tool on scrap material to get the feel of it before attacking a project. If your saw is not too sharp it may leave a small burr on the copper surface. This may be smoothed out by rubbing the side of a round glass jar over the surface of the disc.

This tie-point technique is very flexible. Where practical it pays to plan the layout of all components on the circuit board in advance of construction. The required tie points can then be located and cut before parts are mounted, thus speeding the assembly job. However, if a tie point is forgotten, or if you need more of them, insulated discs can be added at any stage of construction without disturbing already installed parts.

Furthermore, the tie point technique has an unexpected advantage. Since the tie points can be located any place on the circuit board it is practical to mount components salvaged from surplus printed circuit boards. Such salvaged components usually have pigtails too short for reuse by other mounting methods.

One other circuit board hint: After the circuit board is cut to size and its copper surface is cleaned and polished with steel wool or household cleanser, spray the surface with a thin coat of Krylon. The copper surface will stay bright for life and solder will still wet the board as if the Krylon were not there.
During the hot weather that persisted from last summer through early fall, the locality where I live experienced several power brownouts. Not blackouts, but a lowering of the nominal 117 volts ac in order to supply badly needed kilowatts to the adjoining metropolitan area. The measured line voltage dipped from its usual value of 120 volts to the vicinity of 110 to 112 volts. Air conditioners ran at reduced efficiency, lights dimmed somewhat and the automatic pin-spotter at the local bowling alley refused to function. Although some electrical appliances may not suffer from this sort of undervoltage it is a good idea to be able to read the line voltage with a higher level of accuracy than is possible with the average multimeter, which may be off as much as 6 volts (at 120 volts) and still be within tolerance.

There are several commercial ac voltmeters available for this purpose; most common is the iron-vane type. The better instruments are generally accurate to 2% of full scale. On a meter that reads 150 volts full scale this implies an inaccuracy of 3 volts at a line voltage of 120 volts ac. Since most of these instruments are not easy to read at a glance some commercial users and laboratories have changed over to the expanded-scale voltmeter. Simpson makes a fine segmental voltmeter with a mid-scale accuracy of 1/2%, but the high cost puts it beyond the reach of most amateurs and experimenters.

There are several electronic voltmeter circuits where the indicating meter reads all over-voltage above a certain standard. This standard or comparison voltage is a voltage-reference tube or zener diode. When properly calibrated the accuracy of such devices is in the neighborhood of 3%. There are two drawbacks, however: most voltage-reference sources are temperature dependent, and for reasonable accuracy the instrument should be calibrated with a laboratory standard.

The ac line monitor shown in fig. 1 neatly skirts these obstacles. It is simple and requires no calibration. In addition, the cost is lower than you might pay for an equivalent meter.

Basic to this ac voltmeter is the use of a segmental scale voltmeter that reads from 18 to 36 volts dc. My meter, a Marion Electric type HS2 was purchased...
new at a surplus store for slightly under $4.00.* An ordinary silicon rectifier diode is used to furnish approximately 54 volts ac from the 120 volt line. Since the hermetically sealed Marion meter does not lend itself to easy modification I chose to use the 30-volt reading on the scale to correspond to 120 volts ac line voltage. The current drain at the 30-volt mark is 833 μA. (The 30-volt mark is 5/6 of full scale or 83.3%; since the meter has a 1-mA meter (the usual type) current flow at 5/6 full scale is 833 μA.

The value of multiplier resistor is determined with Ohm’s law. Dropping 54 volts dc (from the rectifier) to 30 volts requires 28.8 kilohms for a current of 833 μA. I used two parallel-connected 1% 56k resistors in series with an ordinary 1000-ohm resistor. The total resistance is very close to the desired value of 28.8k.

accuracy

Before talking about the performance of this simple instrument I’d like to explain some of the techniques used to insure that it will provide 1% accuracy without comparison to a lab standard.

First the dc meter was connected in series with four other 1,000-ohms-per-volt dc meters. One of these was a Weston 741 mirror-scale meter, rated at 1% ac-

*The Marion Electric HS2, 2-1/2-inch round, 18- to 36-volt dc meter is available for $3.95 from Fair Radio Sales, Post Office Box 1105, Lima, Ohio 45802. A similar 18 to 36-volt Roller-Smith meter is available for $4 from Jeff-Tronics, 4252 Pearl Road, Cleveland, Ohio 44109.

curacy. Readings were taken at 3-volt intervals; then an identical run was made backward from full scale deflection of 36 volts to 18 volts. Averages of the four other meters were tabulated; the readings of the expanded-scale Marion meter compared closely to the other instruments. The maximum error was 1.25% of full scale and the average error was less than 1%. After the instrument was completed ac accuracy was checked. A mirror-scale Simpson 261 vom was checked at 6.7 volts against a meter of known accuracy, a precision mirror-scale laboratory type ac voltmeter (Weston 433). Since the two readings were in agreement the Simpson 261 readings on the 0 to 10-volt ac scale were trustworthy. When switching to the 250-volt ac range additional precision multipliers are used; however, the basic ac circuitry and accuracy remain essentially the same. When my meter was compared to the Simpson 261, it read 119 volts as opposed to the Simpson’s 119.5 volts.

You may wonder how such high accuracy may be obtained from such a simple circuit. Through segmentation, it is possible to increase the absolute accuracy of the original movement.¹ Proper selection of the multiplier resistors will contribute to the retention of this enhanced accuracy. As with any homemade device care and forethought are important ingredients that will pay off in increased accuracy and dependability.

The Marion meter movement is not highly damped. This allows a very slight flickering of the pointer but it is hardly noticeable. However, it has one definite advantage: Rapid excursions of the ac line voltage, not fully discernible with ordinary voltmeters, can be easily followed. I first noticed this effect when I hooked the ac line monitor to the wall socket where a small air conditioner was plugged in. When the compressor first started up, the ac line dipped - for an instant - to below 100 volts ac!

reference


ham radio

august 1971
AT LAST
THE DYCOMM 10-10
LAND MOBILE

An American made FM Transceiver
For the amateur who needs quality communications
But at a price below the imports

- 10 independent Receive-Transmit Channels
  .34, .82, .88, .94 Transmit — .76, .82, .88, .94 Receive supplied
- Full 20-30 watt output
- Frequency stability .001% —20° to +60°C
- .3μV sensitivity for 20 db quieting
- All solid state
- Control Head 2” x 5” x 6” — Main Unit 2” x 10” x 11”
  Cabling supplied for trunk or other location mount
- FCC type accepted Receiver-Transmitter design

DYCOMM MINI FM BOOSTERS
JUST INSERT BETWEEN YOUR ANTENNA AND TRANSCEIVER,
ADD 12-14 VOLTS AND QSO
ALL WITH AUTOMATIC RF SWITCHING

101-500C “FM BOOSTER”
4-12W input for
12-30W Max output.
Size: 3” x 4” x 4” ............. Price $59.95

101-500D “BLOCK BOOSTER”
8-15W input for
20-55W Max output.
Size: 3” x 4” x 6” ............. Only $89.95

101-500E “BRICK BOOSTER”
1-3.5W input for
10-30W Max output.
Typically 20W out
for 2W in.
Low introductory price only $69.95

10-0 100 WATT FINAL
8-10W input for
100W output.
Just $185.00

WRITE TODAY FOR PRICE AND FULL DETAILS ON
THESE DYCOMM PRODUCTS!

48 august 1971 More Details? CHECK-OFF Page 94
...NEVER BEFORE...

a repeater designed specifically for amateur use.

This compact little package contains a complete 2 meter FM solid-state repeater, including a receiver with useable sensitivity better than .2 microvolts and a transmitter with a guaranteed output of 12 watts (15 watts typical). We think this package is going to revolutionize amateur repeater installations. Look over the spec's and we are certain that you'll agree.

- Solid state — no relays
- Withstands most severe environment, fully weatherproof
- Multiple frequency operation — remote selection capability
- Protected against antenna short or open circuit or mismatch
- Deviation 5 kHz adjustable to 10 kHz
- Desensitization less than .25 microvolt at 200 kHz separation — negligible at 300 kHz
- Power 12-15 volt operation — 40 ma receive — 1.5A transmit
- Terminals provided for all necessary controls and monitoring

Call or write today for information on these exciting New Dycomm Products

JIM W4MRI

DYNAMIC COMMUNICATIONS, INC.
P. O. BOX 10116 · RIVIERA BEACH, FLORIDA 33404
305-844-1323
integrated circuits

Integrated circuits hold great promise for modulation and demodulation applications. The modern transmission modes of single sideband, double sideband, suppressed carrier and frequency modulation, plus phaselock receiving systems, depend a great deal on balanced circuits. This is the forte of integrated circuits with their arrays of identical diodes and identical transistors.

modulators

The diode balanced modulator is widely used in transmitters. IC diode-arrays provide the experimenter with small, well balanced diode assemblies. One example is the RCA CA3019, fig. 1. The CA3019 consists of four bridge-connected diodes plus two additional diodes, all in a miniature 10-pin TO-5 case. Conventional balanced modulator and ring modulator circuits are shown in fig. 2. In fig. 2B the diode between points X and Y consists of CA3019 diodes D1 and D2 in parallel; pin 5 is connected to Y, pins 6 and 2 are connected to X. Similarly, the diode between points X and Z consists of CA3019 diodes D3 and D4 in parallel; pin 8 is connected to Z.

Phasing-type single sideband generation may not disappear from the scene with the advent of integrated circuits. The balance complexities of the phasing system are reduced by the unusual uniformity that can be obtained in integrated-circuit construction. As shown in fig. 3, a combination of CA3018 and CA3050 integrated circuits provide a packaged phase-shift single-sideband modulator.

The RCA CA3018 is a four-transistor IC that can be connected as two Darling-
ton pairs. The audio phase-shift network is connected externally, supplying 90°-related components to the separate inputs of the Darlington pairs; two low-impedance 90°-related outputs are made available. The Barker & Williamson 2Q4 is a good choice for the audio phase shift network.

The RCA CA3050 consists of two
independent differential amplifier arrays. Each array is made up of two Darlington pairs connected as differential amplifiers. Audio signals from the phase-shift IC are applied to their bases. A switch permits the selection of upper or lower sideband.

Additional transistors provide carrier input so the 90°-related carrier components can be applied to the emitter circuits of the independent dual differential amplifiers. The appropriate 90° phase shift networks are connected across the inputs of these transistors. One input consists of series resistor and shunt capacitor; the other, a series capacitor and shunt resistor. If each network provides 45° phase shift, the total phase shift of the two carrier components is 90°. The single-sideband signal is developed across the tuned output transformer.

**demodulators**

Some of the most intriguing ICs are those that contain an i-f amplifier plus capability for various demodulation modes. They lend themselves to the construction of small and versatile receiving systems.1 With such IC versatility I wonder if a compact all-band (1.8 MHz to 144 MHz) all-mode, cw, a-m, fm and ssb receiver is a real possibility?

One particularly interesting IC is the National Semiconductor LM373 a-m/fm/ssb i-f strip. Simple external connections can switch the IC from one mode to another. Bandpass shaping may be accomplished externally over a frequency range from audio to 15 MHz. Agc is also included.

A functional block diagram of the LM373 is shown in fig. 4. The row of stages at the top include an amplifier/limiter, agc and second gain circuit. The signal to be demodulated is applied to pin 2. Output is taken at pin 9, and in most applications, reintroduced at pin 4, passing through an external filter circuit on the way. More gain stages are followed by a balanced mixer and peak detector. With proper external circuitry the latter two circuits can be switched for a-m, fm or ssb. Output voltage ranges from 50 and 120 millivolts rms depending upon mode.

Test circuit connections for a-m, fm and ssb are given in fig. 5. An a-m i-f signal is applied to pin 2, removed at pin 9 and reintroduced at pin 4. Demodulated output is taken from the peak detector at pin 8.

The fm detector uses a quadrature demodulator. The fm i-f signal is applied to pin 2, picked up at pin 9, and through transformer T1 is re-applied at pin 4. The quadrature LC circuit is connected at pin 6; demodulated audio is removed at the output of the balanced mixer at pin 7.
For ssb and cw operation the signal is sent through the amplifier/agc system, pin 2 to pin 9, and is re-inserted at pin 4. The balanced mixer is now used as a product detector with carrier applied to pin 6. Ssb output is again taken at pin 7. An appropriate switch permits selection of agc action for single sideband or manual gain control for CW.

**rf amplifier**

Integrated circuits are not the monsters that you may have been led to believe. That they destroy ingenuity and the yen for experimentation is more evasion than fact. Ingenuity is required to often adapt some of these newer devices for applications very different from the manufacturer’s intended use. To prove the point he built an rf linear amplifier for 80 meters using the popular RCA CA3020 audio power amplifier (fig. 6). A close check of CA3030A specs indicates operation to 8 MHz.

A diagram of the CA3020, fig. 7, shows the isolating input stage (Q1), differential amplifier (Q2 and Q3), driver (Q4 and Q5) and power output stage (Q6).
fig. 6. Integrated-circuit 80-meter linear amplifier designed by G3VJN.

and Q7). The IC also includes a built-in voltage regulator.

We can now look at G3VJN’s circuit in fig. 6 and understand its operation. First of all, input transistor Q1 is not used; signal is applied to pin 3 which is the input to the differential amplifier. Supply voltage is applied to this stage through resistors R1 and R2 to terminal 11.

Push-pull output is taken from the final amplifier at terminals 4 and 7 which connect directly to the collectors of the output transistors. Supply voltage is applied through the coil center tap. The circuit is simple and easily understandable.

fig. 7. Block diagram and internal circuit of the RCA CA3020.
fig. 8. Seiler vfo and output amplifier using the RCA CA3020.

vfo

With the CA3020 you also have the makings of an integrated-circuit vfo, using the input transistor in a Seiler-type vfo. The circuit shown in fig. 8 performs well on 160, 80 and 40 meters. Since linear operation is not required for vfo operation G3VJN's basic circuit can be modified somewhat to obtain slightly more output.

The oscillator is built around pins 1 and 10 which connect to the base and emitter of the input transistor (fig. 7). The emitter output of the Seiler oscillator, pin 1, is connected to the input of the differential amplifier, pin 3, through capacitor C5. Some adjustment of C5 may be needed to obtain optimum output and minimum turn-on drift. Pins 4 and 7 connect to the push-pull rf output transformer. This is a center-tapped primary winding with secondary winding between the two halves of the primary.

A breadboard test unit of this circuit is shown in the photo. To facilitate circuit changes I used a Vector 570-F IC test socket. With this test socket the IC pins are brought out to 12 pressure spring terminals, a real blessing for experimental work.

The RCA CA3020 can also be used as an oscillator and frequency doubler to provide even greater isolation between the output and the oscillator. The circuit of fig. 8 frequency doubles by tuning the output circuit to twice the oscillator frequency.

Greater output can be obtained from the circuit of fig. 9. In this circuit the output transistors are connected in a push-pull frequency doubler circuit. The bases are connected internally in a push-pull circuit that cannot be altered. The push-pull doubler circuit requires that the collectors of the output transistors be connected in parallel as in fig. 9. A single-ended output circuit is used with

fig. 9. Modifying the output circuit of fig. 8 for frequency doubling.

fig. 10. Modifications to the output circuit of fig. 9 for balanced voltage drive to succeeding high-impedance stages.
the collectors connected to the primary tap. Several hundred milliwatts rf output is possible.

The CA3020 circuit arrangement in fig. 10 is ideal for driving a succeeding high-impedance amplifier such as the push-pull input to a vacuum tube or fet. The primary objective of this circuit is to provide good voltage drive to the next stage.

triangle antennas

The full-wave triangle antenna seems like the best “hunk-of-wire” antenna ever; performance-per-penny-spent is exceptional. Only a single mast or other high support point is needed. Since it is fed at the bottom the triangle can be trimmed to resonance with ease.

The basic triangle is a closed full-wave-length antenna, fig. 11, with three equal-length sides. However, within reason, good performance is maintained if the base is longer than the two sides. Conversely, the sides can be longer than the base, within limits, as long as the overall length is one wavelength. The relative length of sides and base influence radiation resistance, therefore simplifying impedance-matching problems.

On 40, 80 and 160 meters you can use coaxial feedline without any supplemental matching system. Simply make certain that the base of the triangle is 8 to 12 feet above ground; at this level the antenna is easy to trim for proper resonance and matching to a given transmission line.

construction

The mounting arrangement consists of a single support mast and a pair of ground stakes. The antenna wire is fed through an insulator at each end of the base and is supported by an insulator at the top of the mast. I use insulated wire such as plastic-covered no. 12, no. 14 or no. 16. The insulation is removed only where the antenna is connected to the transmission line at the center of the base. Nylon rope or plastic clothesline (non-metallic core) is attached to each of the base insulators; the triangle is pulled open and held in position by the two ground stakes.

On the higher bands, 10, 15, 20 meters, a single triangle antenna element can be supported in about the same manner, fig. 12. On these bands use coaxial line or open-wire transmission line and an antenna tuning unit. This provides good performance over the entire band for which the triangle is designed.

To build the high-band triangle measure off three equal sides. Attach the
two base insulators so they cannot slide along the antenna wire. Locate the exact position of the feed point. This can be done with the simple equation in fig. 13.

For example, a full wavelength at 20 meters is:

\[ \lambda = \frac{984}{f_o} = \frac{984}{14.2} = 69 \text{ feet} \]

Each side, S, will be one-third this value or 23 feet.

To set up an equilateral triangle, the separation between the apex and the center feedpoint of the base must be:

\[ h = 0.866S = 0.866 \times 23 = 19.8 \text{ feet} \]

A twenty foot separation between apex and feedpoint is fine.

In erecting the antenna the apex and center feedpoint are attached to the mast. Then the mast is raised. Finally, the ropes attached to the base insulators are used to pull the wire into a triangle.

The triangle antenna has a bi-directional pattern and provides good performance at reasonably low mounting heights. Cost is low; what do you pay for a 69-foot piece of wire and four insulators? On the lower bands the triangle antenna has favorable low-angle directivity. It also operates well with parasitic reflectors and directors and can be used as elements of a phased antenna system.

open triangle

The closed triangle, like the closed quad or delta loop, is a single-band antenna. Operation on other bands is possible using concentric mountings as for three-band cubical quads. The open triangle antenna, when cut for 20 meters provides good bi-directional performance on 10, 15 and 20 meters (see fig. 14). Note that the insulator at the apex of the triangle divides the antenna into two half-wave 20-meter sections. The feedpoint impedance is high and requires an antenna tuning unit with both series and parallel tuning.

The open triangle also loads well and gives reasonable performance on 40 meters. On this band each segment, at 34.5 feet, is a bit longer than a quarter wavelength. Although there is a lot of experimentation to be done with the triangle, it is a good base for high-performance, low-budget antennas.

references
mini-mobile

When my wife first suggested buying a Volkswagen for our first car I was somewhat stunned — knowing it would never materialize into the mobile station I always dreamed of. Going against the odds of placing all by mobile gear in the small Beetle I began to change the VW into a rolling radio station. I hope this article will provide incentive to all hams who own small cars to try mobile operation.

The dc power supply is installed up front in the VW trunk.
In my mobile radio station a Heath ssb transceiver is mounted under the dash on the passenger’s side. It requires some ingenuity in fabricating mounting hardware; however, no special tools are necessary. A standard magnetic mobile microphone holder is mounted on the glove compartment to allow easy access to the microphone with minimum distraction from driving chores. The mobile speaker is mounted next to the microphone. If you wish, the car broadcast radio speaker may be used by placing a toggle switch under the dash that switches the speaker from the car radio to the mobile radio. This is an added advantage in the VW since the speaker is directly in front of the driver.

The dc power supply was mounted in the trunk by cutting an access hole in the trunk liner and fabricating mounting hardware to compensate for the contours of the trunk base. You may question the mounting position of the power supply; however, no problems have been encountered with overheating; even on hot summer days.

The heart of the VW mobile, and the key to its success, is its 12-volt power plant. A separate 35-amp alternator system was installed to eliminate the possibility of overtaxing the VW electrical system. The regulator was installed in the upper left corner of the engine compartment. A separate battery was installed under the rear seat with battery cables running to the power supply in the trunk.

When I work fellow VW owners on the air they invariably ask me how it was done. It is hoped the ideas presented here will make it possible for other VW owners to have a mobile radio station. For those of you who are wondering about the added drag of the alternator, I found that approximately 3 to 5 mph was knocked off the top speed; however, there was no noticeable decrease in gas mileage.

*Alternator, part number RM 12V PAK, available from 767 Minot Avenue, Auburn, Maine 04210.
motorola fm receiver mods

During the past year I have retuned several 43G and 43GGV Motorola Sensicon transceivers for amateur use on two meters. In some of the units I discovered that the squelch control had to be advanced almost fully clockwise to quiet the channel. After checking tubes, components and voltages and a careful alignment I still could not find the problem. Checking through a number of manuals, I found some resistor changes in the schematic for a late T-Power receiver strip. When these resistor values were incorporated in an otherwise identical older version of the receiver the result was vastly improved squelch-control action. The new resistor values are shown in table 1.

To provide a measure of protection to the 6AQ5 audio output stage I installed a 120-ohm, 1-watt resistor between the cathode (pin 2) and ground, bypassed with a 50-µF, 25-V capacitor. Gain of the stage is not greatly affected, and the tube will be protected by self-bias.

Table 1 lists a number of dc voltage readings at various points in the squelch and audio stages. These should be helpful in tracking down circuit ailments.

Murray Ronald, VE4RE

multiple tubes in parallel grounded grid

The use of four parallel tubes in grounded-grid dates back many years. If the tubes are honest-to-goodness triodes like the 811A they work pretty well. However, if you use tube-type horizontal-amplifier tetrodes or pentodes, tie all of the grids together and ground them, the picture is a little different. When you get that much grounded hardware in close proximity to the plate of the tubes the plate-to-ground capacitance becomes formidable, particularly when you have four tubes in parallel.
Several years ago I built such an amplifier using four 6KG6 Amperex tubes. These tubes are somewhat huskier than the 6LQ6 and harder to come by, but they will take a lot of abuse. I have run the four of them to a full 1000 watts dc. One tube finally blew so power was dropped to a conservative 500 watts dc (1000 watts PEP).

At the lower frequencies the standard grounded-grid circuit shown in fig. 1A worked fine. However, at the higher frequencies the plate-to-ground capacitance is on the same order of the tuning capacitor and in parallel with it. Result: poor efficiency on 15 meters and impractical on 10 meters.

Recently I decided that I wanted to use this amplifier on 10 and 15 meters, but first I had to solve the high-C dilemma. The solution is shown in fig. 1B. In 1B the input pi-network capacitor C1 is placed in series with the plate-to-ground capacitance. With this arrangement capacitor C1 becomes the series combination of the plate-to-ground capacitance of the four tubes and the variable tuning capacitor. You have to insulate both sides of the tuning capacitor from ground now but this is no big problem.

With circuit 1A on 15 meters the tank coil consisted of two very hot turns; with fig. 1B the tank circuit has 6 turns and everything runs cool, as it should. I drive the amplifier with an SB-34 transceiver. One other major improvement was incorporated into the rebuilt amplifier. The original circuit used a 100-ohm cathode-bias resistor (fig. 1A). This is a poor way to bias a variable-plate-current power amplifier. The bias circuit in fig. 1B uses fifteen series-connected silicon rectifiers to obtain a 10-volt drop which is constant and limits the resting current to about 60 mA. The cost of this arrangement was kept down by using surplus 100 PIV 1500 mA silicon diodes that are available from Poly-Paks for less than a dime apiece. A more expensive approach to the bias problem is a 10-volt, 20-watt zener diode.

The rebuilt linear delivers a very clean signal. Although I used 6KG6 tubes the same technique may be used to solve the high plate-to-ground capacitance of any parallel-connected tv sweep tubes.

Bob Baird, W7CSD
Dear HR:

I just wanted to let you know that some of us actually build equipment described in *Ham Radio*. I’m enclosing a photo of a ssb exciter I came up with after reading W9K1T’s article in the December issue. The basic 9-MHz section is basically the same as that described in the article, although I haven’t put the crystal filter in yet.

In correspondence with the author I got the dope on his entire ssb exciter, and followed his heterodyning scheme pretty much, although I used transistors and he used vacuum tubes. The double-balanced mixers work out nicely; although this is my first experience with them I remember an article you ran on these gadgets some time ago.

It sure is a kick to work somebody on phone and tell them I’m using a home-brew rig. Most of the guys are never aware that I’m using double sideband unless I tell them, so I may never get around to putting in the crystal filter as I’m primarily interested in cw anyway! This little rig drives my 6146 final to about 60 watts PEP input which seems to be plenty to make contacts on 40-meter ssb.

Cal Sondgeroth, W9ZTK
Mendota, Illinois

---

Dear HR:

In the article “Fire Protection in the Ham Shack” in the January 1971 issue, Freon is listed as being a good fire extinguisher. Possibly it would be good for putting out the fire, but might hospitalize the fireman. When subjected to temperatures corresponding to that of red-hot metal, Freon breaks down, forming Phosgene gas, which my dictionary describes as a colorless, highly toxic gas; one use of which is chemical warfare. As personal experience followed by research has taught me, phosgene is a lung irritant, also an eye irritant and very good for rusting tools. The authors are not to be blamed too harshly. Freon is non-toxic, stable and non-inflammable — but only at ordinary temperatures.

Frank Knottingham, K7QCM
Gold Beach, Oregon

---

A set of schematics for W9ZTK’s solid-state ssb exciter for 80, 40 and 20 meters is available for 25c from *Ham Radio*. The circuit includes a 9-MHz sideband generator, speech amplifier, vfo, double-balanced mixers for 80, 40 and 20 meters plus an fet output amplifier. editor
10 years ago the mobile antenna concept shook the ham fraternity with "fixed station reports from the mobile"—it has since been the most imitated but never equalled!

Hustler and only Hustler gives you 10 years of proven performance, mechanically and electrically superior to all others. You get exceptional reports on every band, lowest SWR and broadest bandwidth. Matching devices are not required. Use any convenient length of 52 OHM feed line. Choose from either standard or super resonators and buy the mast and resonators for the bands you operate.

Convenience of fold-over mast for rapid band change or easy garaging, optimized performance on each band and a time proven concept in mobile communications, a concept verified by the overwhelming majority of amateurs, are yours only with Hustler!

Model MO-1—54" Mast for Deck or fender mount—Folds at 15" above base. Price: $11.95
Model MO-2—54" Mast for Bumper mount—Folds at 27" above base. Price: $12.25

STANDARD HUSTLER RESONATORS—400 Watts Power—Normal SSB Duty Cycle

<table>
<thead>
<tr>
<th>Model</th>
<th>Band (meters)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM-10</td>
<td>10</td>
<td>$7.95</td>
</tr>
<tr>
<td>RM-15</td>
<td>15</td>
<td>8.95</td>
</tr>
<tr>
<td>RM-20</td>
<td>20</td>
<td>9.95</td>
</tr>
<tr>
<td>RM-40</td>
<td>40</td>
<td>11.95</td>
</tr>
<tr>
<td>RM-75</td>
<td>75</td>
<td>13.95</td>
</tr>
<tr>
<td>RM-80</td>
<td>80</td>
<td>13.95</td>
</tr>
</tbody>
</table>

SUPER HUSTLER RESONATORS—Legal Power Limit—Normal SSB Duty Cycle

<table>
<thead>
<tr>
<th>Model</th>
<th>Band (meters)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM-10S</td>
<td>10</td>
<td>$11.50</td>
</tr>
<tr>
<td>RM-15S</td>
<td>15</td>
<td>13.50</td>
</tr>
<tr>
<td>RM-20S</td>
<td>20</td>
<td>15.50</td>
</tr>
<tr>
<td>RM-40S</td>
<td>40</td>
<td>19.50</td>
</tr>
<tr>
<td>RM-75S</td>
<td>75</td>
<td>24.50</td>
</tr>
<tr>
<td>RM-80S</td>
<td>80</td>
<td>24.50</td>
</tr>
</tbody>
</table>

The original hinge and sleeve clutch mechanism.
Rotates 360° in horizontal plane

Available from all distributors who recognize the best!

NEW-TRONICS CORP. 15800 COMMERCE PARK DRIVE BROOK PARK, OHIO 44142
Export Dept., Roburn Agencies, Inc., 349 W. 14th St., New York, N.Y. 10014, Cable Address: Roburnage-New York

More Details? CHECK-OFF Page 94

august 1971
The new Palomar Engineers frequency standard contains a crystal-controlled oscillator that is based on a precision 100-kHz crystal. A front-panel switch controls the operation of three frequency dividers driven by the 100-kHz oscillator. They provide outputs at 100, 50, 25, 10 and 5 kHz, depending on the switch setting. The output is a square wave with rich harmonic content; thus the signal can be heard at every 100 kHz (or every 50 kHz, or every 25 kHz, etc.) throughout the shortwave bands to 50 MHz and above.

afsk generator

The new J&J solid-state afsk generator provides short-term stability of ±1 Hz. The basic oscillator uses a unijunction transistor in an RC circuit with precision resistors. The internal 5-pole butterworth filter with cutoff above 3000 Hz removes harmonics and assures sinusoidal output.

The J&J afsk generator features high output with more than ample transmitter drive. The high level line output may be used to test TUs or other RTTY equipment. The generator may be triggered by any positive voltage greater than 2 volts. A keyboard can be connected to the input of the generator with a power supply up to 20 volts to cause the unit to conduct on space. The afsk generator can also be operated directly from any of the TT/L or equivalent keying circuits which supply a positive voltage on space.

The J&J afsk generator is furnished with standard tones 2125, 2295 and 2975 Hz unless otherwise specified. Price, in modern desk-top cabinet, is $90.00; $99.00 for rack-mounted model (3 1/2" panel). Also available with low tones of 1275, 1445 and 2125 Hz at $99.00. Order from J&J Electronics, Windham Road, Canterbury, Connecticut 06331. For more information use check-off on page 94.
broadband rf amplifiers

The new broadband rf amplifiers introduced by Radiation Devices Company span the region from 10 to 500 MHz for state-of-the-art performance for laboratory or field use. Gain is 30-dB minimum from 10 to 150 MHz; gain from 3 to 500 MHz is 10 dB for the model BBA-1 and 15 dB for the BBA-1P. Noise figure, from 10 to 500 MHz, is 6 dB maximum for the BBA-1, and 3 dB maximum for the BBA-1P. The broadband amplifiers require a supply voltage of 12 volts, ±1 volt. Input and output connectors are type BNC (other connectors available). The BBA-1 is priced at $30; the BBA-1P is priced at $45. For more information, use check-off on page 94, or write to Radiation Devices Company, Post Office Box 8450, Baltimore, Maryland 21234.

high-voltage silicon rectifiers

Semtech has announced the development of a unique high-voltage silicon rectifier device, called the KV-PAC, with peak inverse voltages up to 15 kV. The KV-PAC offers a rugged functional pack-
New
3 Digit Counter

The model fm-36 3-digit frequency meter has the same features that has made the 2 digit model so popular with Hams—low price, small size (smaller than a QSL card), 35 Mhz top frequency, simple connection to your transmitter, ±0 -0.1 KHz readout — PLUS the added convenience of a third digit to provide a 6 digit capability. Kit or Assembled.

Example: 28.649.800 Hz reads 28.6 MHz or 49.8 KHz. (Add the 10 Hz module to read 9.80.)

A divide-by-ten prescaler is also available that operates up to 170 Mhz. Extend the range of any frequency counter — or use with the fm-36 for 6 meter or 2 meter use.

FM-36 KIT $134.50
FM-36 ASSEMBLED $164.50

Micro-Z Co.
Box 2426 Rolling Hills, Calif. 90274

AT LAST--
A SPEECH COMPRESSOR THAT REALLY WORKS!

RPC-3M MODULE
(ONLY $22.50)
- LOW DISTORTION CIRCUIT
- FULLY WIRED & TESTED NOT A KIT
- WORKS WITH PHONE PATCH
- INTERNAL UNITS & MODULES WORK MOBILE
- FULL WARRANTY —ONE YEAR
- INTRODUCTORY LOW PRICES
(Illinois residents add 5% Sales Tax)
Write for specifications and information sheets (free)
Demonstration Tape (cassette) available ($2.00 deposit)

RPC-3C CABINET MODEL ($34.95)
RPC-3.30 INTERNAL UNIT ($24.95)

RP Electronics
BOX 1201H
CHAMPAIGN, ILL.
61820

age that is corona free. Mounting slots are designed for easy installation. Universal 3-watt electrical terminals accommodate fast-disconnect fittings, wire wrap or solder connections. The devices are rated at 5 to 15 kV PIV per leg. Average rectified current is 0.4 amp; one-cycle surge current is 50 amps. Reverse current at the rated PIV is 10 μA. For more information, use check-off on page 94, or write to Semtech Corporation, Newbury Park, California 91320.

stud-nut

The Stud-Nut is a new unitized fastener which eliminates five separate pieces of hardware now required to mount stud-type solid-state devices. It replaces an insulating bushing, mica washer, metal washer, solder lug and hex nut; it provides rapid, secure mounting of SCRs, power transistors, rectifiers and zener diodes with 10-32 threaded studs. It can be used with DO-4, TO-36, TO-59, TO-60 and TO-64 case types.

The threaded metal insert is molded into an insulated hex base and contains through holes to provide solder connections for external leads. Due to the unique design of the Stud-Nut the contact resistance between the stud-mounted device and external lead is extremely low. Continuous current rating is 30 amperes.

For more information, use check-off on page 94. A package of four Stud-Nuts is available for $1.00 postpaid from the SCF Corporation, Post Office Box 999, Hightstown, New Jersey 08520.
The recently announced type 107A digital frequency meter/signal generator/synthesizer from Lampkin Laboratories is an extremely versatile instrument that is aimed primarily at the mobile-radio maintenance field. The instrument has many applications in educational, aerospace and industrial laboratories; in manufacturing, research, and production operations; in a-m, f-m, and tv broadcast engineering and receiver servicing; in commercial frequency-measurement services and in many other applications. It is completely solid-state, operates from either 12 Vdc or 115 Vac and weighs 22 pounds.

As a heterodyne frequency meter, the 107A will measure carrier frequencies of nearby transmitters or signals picked up on a receiver. Coverage on FCC-assigned frequencies is continuous from 10 kHz to above 500 MHz. Guaranteed accuracy in the field, independent of WWV, is considerably better than 0.0001% (1 part per million).

As a synthesizer any frequency from below 1,000 Hz to 9,999.9 Hz, can be generated, in steps of 100 Hz, phase-locked to the internal crystal standard. Voltage output level is 1.0-volt rms down to 0.0005-volt, continuous and calibrated, into 50-ohm load or greater. As a signal generator the 107A provides cw, amplitude or frequency-modulated signals on fundamental frequencies up to 10 MHz; from 10 MHz to above 500 MHz harmonics are employed, but no arithmetic is needed – the dials are direct reading in MHz and kHz. An external variable attenuator (supplied) will bring the signal below the noise level of receivers.
ALL SOLID-STATE SSB TRANSCEIVER

$195.00

- Complete single-band SSB transceiver 4 to 5 watts PEP output 15, 20, 40, or 75 mtrs.
- VXO tuning up to 100 KHz or 2 fixed freq.
- Suitable for dry battery operation.
- Light weight, small size makes excellent portable boat, aircraft, field or mobile.
- Contains 15 transistors, 1 MOSFET, 2 darlington amps., 1 I.C. and 17 diodes. Four-pole filter.
- Some options available to customer requirements.
- Furnished with spare switching and final amp. transistors, dummy load and extra plug.

JUSTIN, INC.
2663 NORTH LEE AVENUE
SOUTH EL MONTE, CALIF. 91733

NEW! IC KEYER

Only $77.50

- Self completing dots and dashes.
- Dot memory for easy keying.
- Precision feather-touch key built-in.
- Sidetone oscillator and speaker built-in.
- Relay output keys 300-V @ 100-ma.
- Keyed time base. Instant start.
- 5-50 wpm. Perfect dot-dash ratio.
- Send QSL or postcard for free brochure.

PALOMAR ENGINEERS
BOX 455, ESCONDIDO, CAL. 92025

Price of the Lampkin 107A is $2150.00. For further information, write Lampkin Laboratories, Inc., Dept. 243, 8400 Ninth Avenue N.W., Bradenton, Florida 33505.

vhf marine radio

Every marina or yacht club, or any marine service company, can now afford its own VHF Limited Coast Station with the Ensign II produced by RF Communications. Ideal for marine sales and service dealers to have as a unit to show, demonstrate and use, all at the same time, the Ensign II provides full 25-watt output. Transceiver weight is under 7 pounds, and the unit includes crystals aligned for channel 16 and a working channel ready for use. Capable of being mounted in any position, the Ensign II is housed in a vinyl painted cabinet with drip-proof and dust-tight construction. List price is $578.

A complete line of antennas and accessories is also available. For literature with full specifications and further information use check-off on page 94, or contact National Sales, RF Communications, Inc., a subsidiary of Harris-Inter-type Corp., 1680 University Avenue, Rochester, New York 14610.

wwv changes

When you tune in WWV (or WWVH) for time signals or propagation information after 0000 hours gmt, 1 July 1971, you will hear a different format than you've been accustomed to over the last few years. The Morse code transmissions will be gone and the announcements of time and other information will be made in voice. The time will be announced
every minute instead of every five minutes; a male voice will be used by WV and a female voice by WWVH to distinguish between them. The carrier frequencies will remain the same: 2.5, 5.0, 10.0, 15.0, 20.0 and 25.0 MHz. The frequency accuracy of the two stations is controlled by the NBS Atomic Frequency Standard at Boulder, Colorado.

The format of the broadcasts from the two stations will be similar, but to avoid confusion they will use alternate time slots for the transmission of tones, announcements, etc. The standard time tick each second will remain.

Each hour will be divided into 1-minute slots. Each minute (except the first) will begin with an 0.8-second 1000-Hz tone on WV (1200 Hz at WWVH). The first minute of each hour will begin with a 1500-Hz tone at both stations. The one minute slots will be divided into a 45-second segment and two 7.5-second segments. On alternate minutes the 45-second segment will contain either a standard tone or an announcement. The first 7.5-second segment following the 45-second segment will be used by WWVH to announce time while WV will be silent. The second 7.5-second segment will be used by WV to announce time, WWVH being silent.

Each station will omit for 5 minutes of each hour all tones and announcements during the 45 second segments. This period will begin for WV at 45 minutes past the hour and for WWVH at 15 minutes past the hour. A special 440-Hz tone will be broadcast by WV for 45 seconds beginning one minute past the hour and by WWVH two minutes past the hour. This tone can be used to mark the hours on strip-chart recorders or other markers. The tone will be omitted during the zero hour (gmt) of each day.

It is interesting to note that announcement slots will be available to Government agencies to use for their own purposes. The slots not used will be filled by a standard tone, probably 500 Hz. To prevent interference between the two stations one station’s announcements will coincide with the other’s tone.
<table>
<thead>
<tr>
<th>Receiver</th>
<th>600-R</th>
<th>10-80 meters</th>
<th>$395</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter</td>
<td>600-T</td>
<td>600 watts</td>
<td>10-80 meters</td>
</tr>
<tr>
<td>Transceivers</td>
<td>500-CX</td>
<td>550 watts</td>
<td>10-80 meters</td>
</tr>
<tr>
<td></td>
<td>270B</td>
<td>260 watts</td>
<td>10-80 meters</td>
</tr>
<tr>
<td></td>
<td>250-C</td>
<td>240 watts</td>
<td>6 meters</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>400 watts</td>
<td>160 meters</td>
</tr>
<tr>
<td></td>
<td>FM-2X</td>
<td>10 watts</td>
<td>2 meters (FM)</td>
</tr>
<tr>
<td>Linear Amplifiers</td>
<td>MARK-II</td>
<td>2000 watts</td>
<td>10-80 meters</td>
</tr>
<tr>
<td></td>
<td>1200 W</td>
<td>1200 watts</td>
<td>10-80 meters</td>
</tr>
<tr>
<td></td>
<td>MARK 6B</td>
<td>2000 watts</td>
<td>6 meters</td>
</tr>
<tr>
<td></td>
<td>VHF-150</td>
<td>240 watts</td>
<td>2 meters</td>
</tr>
<tr>
<td>Antennas</td>
<td>Tri-band Beams</td>
<td>10-15-20 meters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trap Vertical</td>
<td>10-80 meters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mobile Antennas</td>
<td>Single and Multi-band</td>
<td></td>
</tr>
</tbody>
</table>

PLUS MANY ACCESSORY ITEMS

**SWAN'S 1972 CATALOG**

**ORDER YOUR COPY TODAY**

SWAN FACTORY
305 Airport Road
Oceanside, Ca 92054
Phone: (714) 757-7525

SWAN ELECTRONICS
A Subsidiary of Cubic Corporation

EASTERN OFFICE
P.O. Box 2288
Ocean, NJ 07712
Phone: (201) 531-4114
NCX-1000  **THE 1000 WATT TRANSCEIVER of the 70'S**

- **NCX-1000** $899.00
- **HRO-500** $1995.00
- **HRO-600/601** $3380.00
- **NCX-1000** $899.00
  - 5 BANDS
  - 4 MODES
  - SOLID STATE DESIGN

89 WASHINGTON STREET, MELROSE, MASSACHUSETTS 02176
TEL: 617-662-7700
TWX: 617-665-5032

Write for Specifications!

Excellence in Communications Since 1914

NATIONAL RADIO CO., INC.
Complete packaged Multi-Band Antenna Systems employing the famous Bassett Sealed Resonators and a special Balun. Air has been evacuated from both and replaced with pure helium at one atmosphere.

Highly efficient system packages including all hardware, insulation, coax cable, and copperweld elements assembled at the factory. Complete installation instructions included.

Multi-frequency models available for all amateur bands and for commercial use, point to point, ground to air, military and government.

MODEL DGA-4075
A complete system package for primary use in the 40 and 75 meter bands at power levels up to 4KW-PEP with secondary operation in other bands at reduced power levels.

MODEL DGA-4075 - $59.50

MODEL DGA-204075
A complete system package for primary use in the 20, 40, and 75 meter bands at power levels up to 4KW-PEP with secondary operation in other bands at reduced power levels.

MODEL DGA-204075 - $79.50

CONTACT YOUR DISTRIBUTOR OR WRITE FOR DATA

Savoy Electronics, Inc.
P.O. Box 7127 - Fort Lauderdale, Florida 33304
Tel: 305-566-8416 or 305-947-1191
for the experimenter!

INTERNATIONAL EX CRYSTAL & EX KITS
OSCILLATOR • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER

1. MXX-1 TRANSISTOR RF MIXER
A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX oscillator are used for injection in the 60 to 170 MHz range. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering)..........................$3.50

2. SAX-1 TRANSISTOR RF AMP
A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering)..........................$3.50

3. PAX-1 TRANSISTOR RF POWER AMP
A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw, depending on the frequency and voltage. Amplifier can be amplitude modulated. Frequency 3.000 to 30,000 KHz..........................$3.75

4. BAX-1 BROADBAND AMP
General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 5 to 30 db gain, ideal for SWL, Experimenter or Amateur..........................$3.75

5. OX OSCILLATOR
Crystal controlled transistor type. Lo Kit 3,000 to 19,999 KHz, Hi Kit 20,000 to 60,000 KHz. (Specify when ordering)..........................$2.95

6. TYPE EX CRYSTAL
Available from 3,000 to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is ± 0.02% when operated in international OX circuit or its equivalent. (Specify frequency)..........................$3.95

for the commercial user
INTERNATIONAL PRECISION RADIO CRYSTALS

International Crystals are available from 70 KHz to 160 MHz in a wide variety of holders. Crystals for use in military equipment can be supplied to meet specifications MIL-C-3006E.

CRYSTAL TYPES:
   (GP) for "General Purpose" applications
   (CS) for "Commercial Standard"
   (HA) for "High Accuracy" close temperature tolerance requirements.

WRITE FOR CATALOG.

INTERNATIONAL CRYSTAL MFG. CO., INC.
10 NO LEE • OKLA. CITY, OKLA. 73102

More Details? CHECK-OFF Page 94
Year after year, Collins S/Line consistently holds the top spot in ham radio.

The reason: performance. Collins S/Line still is unsurpassed in important areas such as □ high stability and sensitivity □ accurate tuning with readable dials and smooth controls □ clean, strong signals □ system engineering □ low life-cycle cost □ proven reliability □ handsome styling.

If you're particular about having the finest amateur equipment, look over the S/Line at your Collins distributor.
If you have any interest in the frequencies above 30 MHz then you need this book. It is probably the most comprehensive work of its kind ever produced. Included is simple material for the beginner in VHF and advanced material to satisfy the most experienced and critical reader. A wide range of information is included covering such topics as propagation, tuned circuits, mobile equipment, single sideband and antennas. There are 65 pages devoted exclusively to receivers and 80 pages to transmitters, more information than ever before.

Previous editions of this book have set a high standard in this field for a long time and this latest edition is sure to be no exception.

Regularly $5.95
Special Introductory Price $4.95
(Through September 15 only)
Portable, mobile, or fixed
Six channel capacity, transistorized
Antenna: built-in/external connector
Works barefoot or with amplifier
External 12 VDC or internal ni-cads

all this performance for only

$199.95 Amateur Net

INCLUDES: Dynamic Microphone, Over-the-Shoulder Carrying Case, 120 VAC and 12 VDC Power Cords, Speaker/Headphone Plug, and 10 Nickel-Cadmium Batteries.

+$149.95 for Amplifier, Model AA-22
+$349.90 for superior power, flexibility and sensitivity

See your Dealer

R.L. DRAKE COMPANY
540 RICHARD ST., MIAMISBURG, OHIO 45342
Semiconductor Supermart

- HEP - FAIRCHILD - RCA - MOTOROLA - NATIONAL

MOTOROLA HEP SEMICONDUCTORS

NEW FUNCTIONAL ICs
- C6004 1-W Audio Power Amp $2.60
- C6010 W'band Amp-RF-IF-Audio $1.59
- C6001 FM IF Diff. Amp. $2.09

JUNCTION FETS
- HEP-802 N-channel RF $1.59
- HEP-801 N-channel Audio $1.59

DUAL-GATE FETS
- F2004 VHF RF Amp-Mixer $2.50
- F2007 VHF RF Amp-Mixer; Diode Protected LOW-NOISE 2.6 dB at 200 MHz $1.65

HEK-3 RADIO AMATEUR KIT
Contains (2) HEP-590, (1) HEP-570 plus book w/10 Ham Projects $5.95

HEK-2 FET EXPERIMENTERS KIT
Contains HEP-801, HEP-802, HEP-50, HEP-51 and Instructions for 9 Projects $3.95

MOST MOTOROLA, RCA, & FAIRCHILD LINEAR IC's AVAILABLE .... WRITE US WITH YOUR NEEDS.

TO TROUBLESHOOT FAST & EASY

USE: SERVISET Model E-C

INTRODUCTORY PRICE JUST
$29.95 POSTPAID

FREE INFORMATION

COMPARE!
- Functions
- Features
- Size
- Weight
- Cost

SERVISET MODEL E-C will out-perform any tester of it's size, weight, & price ANYTIME-ANY WHERE.

IDEAL for: Professionals, Amateur Repair men, Ham Radio Operators, STUDENTS, appliance repairmen, etc. Will complement your existing equipment and will outperform other testers costing many times more.

30-DAY UNCONDITIONAL MONEY BACK GUARANTEE, 90 DAY PARTS WARRANTY—ORDER TODAY—

LEE ELECTRONIC LABS, 88 Evans Street, Watertown, Mass. 02172

78 August 1971 More Details? CHECK-OFF Page 94
KENWOOD

...the value line of the 70s

R-599 SOLID STATE RECEIVER AND T-599 HYBRID TRANSMITTER OFFERS UNIQUE FEATURES, SUPERB PERFORMANCE, HIGH STYLE...THE ULTIMATE IN VALUE

THE R-599 RECEIVER: 1.8 to 29.7 MHz (amateur bands) • .5 microvolt sensitivity nominal • Dial readout to ½ kilocycle • Special detectors for SSB, AM, and FM • Transceive operation with T-599 • Built-in 100 kc and 25 kc crystal calibrator • Built-in 500 cycle CW filter • Provision for 2 and 6 meter coverage with optional accessory self-contained converters • Adjustable threshold squelch • The price...only $298.00
S-599 speaker $14.50 • CC-29 2 meter converter $29.50 • CC-69 6 meter converter $29.50

THE T-599 TRANSMITTER: Clear, stable, selectable sideband, AM and CW • 4-way VFO • Flexibility plus Receiver Incremental Tuning (RIT) when used with the R-599 • Amplified ALC • Built-in VOX • Full metering, including cathode current, plate voltage, ALC and relative Power Output • Built-in CW Sidetone monitor and semi-automatic break-in CW • Built-in power supply • Maximum TVI protection • Employs only 3 vacuum tubes • The price...$345.00

KENWOOD IS AVAILABLE FROM ONE OF THE FOLLOWING SELECT DEALERS:

HENRY RADIO 11240 W. Olympic Blvd., Los Angeles, CA. 90064 477-6701 • 931 N. Euclid Ave., Anaheim, Ca. 92801 772-3200 Butler, Mo. 64730 679-3127

ADIRONDACK RADIO SUPPLY 185 W. Main St., Amsterdam, New York 12010 842-8350

AMATEUR ELECTRONIC SUPPLY 4828 W. Fond du Lac, Milwaukee, Wis. 53216 442-4200

AMATEUR RADIO CENTER 2805 N.E. 2nd St., Miami, Florida 33137 374-4101

AMATEUR RADIO SUPPLY 6213 13th Ave. S., Seattle, Wash 98108 767-3222

STAN BURGHARDT 315 10th Ave. N.W., Watertown, S.D. 57201 886-3767

COMMUNICATIONS WORLD 4788 State Road, Cleveland, Ohio 44109 398-6363

DERRICK ELECTRONICS 108 E. El Paso, Broken Arrow, Okla. 74012 251-9923

DOUGLAS ELECTRONICS 1118 S. Staples, Corpus Christi, Texas 78404 883-5103

ELECTRONIC CENTER 107 3rd Ave. N., Minneapolis, Minn. 55401 338-8461

ELECTRONIC DISTRIBUTORS 1960 Peck St., Muskegan, Mich. 49441 726-3196

ERICKSON COMMUNICATIONS 4657 N. Ravenswood, Chicago, Ill. 60640 334-3200

FRECK RADIO & SUPPLY 38 Biltmore Ave., Asheville, N.C. 28801 294-9551

HARRISON Rt. 110 at Smith, Farmingdale, N.Y. 11735 293-7990 8 Barclay St., N.Y. City 227-7922

HAM RADIO CENTER 5342 Olive Blvd., St. Louis, Mo. 63132 993-6060

HAM RADIO OUTLET 999 Howard Ave., Burlington, Ca. 94010 342-5757

INDUSTRIAL DISTRIBUTORS 1209 S. Industrial Ave., Dallas, Texas 75207 742-8570

JRS DISTRIBUTORS 646 W. Market St., York, Penn. 17404 854-8624

KASS ELECTRONICS 2502 Township Line Rd., Drexel Hill, Penn. 19026 449-2300

MADISON ELECTRONICS 1508 McKinney Ave., Houston, Texas 77002 224-2668

PORTLAND RADIO SUPPLY 1234 S.W. Stark St., Portland, Or. 97205 228-8647

RADIO DISTRIBUTING CO., INC. 1212 High St., South Bend, Indiana 46624 288-4666

RADIO SUPPLY & ENGINEERING CO., 85 Selden Ave., Detroit, Michigan 48201 831-3175

WESTERN RADIO 1415 India St., San Diego, Calif. 92101 239-0361

WORLD RADIO LABS 3415 W. Broadway, Council Bluffs, Iowa 51501 328-1851

More Details? CHECK-OFF Page 94
QSK Mk II

... for the ULTIMATE in CW OPERATION

The QSK Mk II is a station control system that will permit you to hear other stations between your transmitted dots and dashes at speeds up to 60 wpm ... full break-in cw!

* Provides high speed antenna switching, exciter keying and receiver isolation
* All band operation—no adjustments, simple installation, fully assembled
* Will not cause TVI, cross modulation or receiver desensitization
* Use with virtually any exciter/PA and receiver combination
* Proven in traffic, contest and DX work. Changes ordinary QSO's into a mode that is as effective as a telephone conversation!

8 transistor 9 diode printed timing and sequencing circuit assures cold switching of vacuum relay. 5 kw rating. Negligible losses. 110vac internal power supply. 4 x 5 x 6 inch metal enclosure. UHF and phono connectors. See your dealer or factory direct. Allow two weeks for shipping. N.J. residents add 5% tax.

$119.95 Post Paid U.S.A.

DYNAMIC TECHNOLOGY INTERNATIONAL, INC.
8 FELLOWSHIP ROAD, CHERRY HILL, N.J. 08034

The STANDARD, by Heights

Light, permanently beautiful ALUMINUM towers

THE MOST IMPORTANT FEATURE OF YOUR ANTENNA IS PUTTING IT UP WHERE IT CAN DO WHAT YOU EXPECT.

RELIABLE DX — SIGNALS EARLIEST IN AND LAST OUT.

ALUMINUM Towers

And now, with motorized options, you can crank it up or down, or fold it over, from the operating position in the house.

The “Standard” can be assembled on the ground with nothing more than a wrench and a spade. No guys, no climbing necessary. Strong and beautiful.

See your local distributor, or write for 12-page brochure giving dozens of combinations of height, weight and wind load.

NOW In New Larger Facilities to expedite your orders.

HEIGHTS MFG. COMPANY
Almont Heights Industrial Park
4516 North Van Dyke, Almont, Michigan 48003

august 1971

More Details? CHECK-OFF Page 94
**NEW G&G CATALOG! MILITARY ELECTRONICS**

24 PAGES, crammed with Gov't Surplus Electronic Gear - the Biggest Bargain Buys in America! It will pay you to refer your copy - Refunded with your first order.

---

**BC-645 TRANSCEIVER**
15 tubes, 435 to 500 Mc. Easily adapted for 2-way voice or code on Ham, Mobile, Aeronautical Experimental, and Citizens bands. With tubes, less power supply. In factory carton, BRAND NEW... $16.95

**TRANSMITTER**
Has 4 tubes: WE-36A, 2-666, 717
RECEIVER has 11 tubes: 2-955, 4-717, 2-766, 3-187
RECEIVER L.F.: 40 Megacycles
SIZE: 10-1/2" x 12-1/2" x 4-1/2", Shpg wt 25 lbs.

**SPECIAL PACKAGE OFFER.**
BC-645 Transceiver, Dynamo and all accessories, including mounting, UHF Antenna Assemblies, control box, complete set of connections and plugs.

**Brand New.** $26.95

---

**HEADSET**
Low impedance, with large channel ear cushions. 4-ft cord and plug. Reg. $12.50. Our Special Price $2.95
Less ear cushions... $1.95

High impedance adapter for above... $ 6.9

---

**SCR-274-N, ARC-5 COMMAND SET HQ!**

<table>
<thead>
<tr>
<th>Freq.</th>
<th>Designation</th>
<th>Type</th>
<th>Complete with Tube</th>
<th>Like New</th>
<th>Brand New</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-28K</td>
<td>BC-645</td>
<td>BC-485</td>
<td>$16.95</td>
<td>$23.50</td>
<td>$27.50</td>
</tr>
<tr>
<td>6-9.1 Mic</td>
<td>BC-645</td>
<td>BC-485</td>
<td>$16.95</td>
<td>$23.50</td>
<td>$27.50</td>
</tr>
<tr>
<td>10-20 Mic</td>
<td>BC-645</td>
<td>BC-485</td>
<td>$16.95</td>
<td>$23.50</td>
<td>$27.50</td>
</tr>
</tbody>
</table>

**TRANSCEIVERS.**

| 6-9.1 Mic | BC-645 | $6.95 |
| 10-20 Mic | BC-645 | $6.95 |

**TQ-34A CODE KEYER.**
Self-contained, automatic, reproduces code practice signals from tape paper. 5 to 12 WPM Built-in speaker. Brand new with tech manual, tape reel and AC line cord... $24.50

**Code practice tapes for above.** $1.25

---

**BC-1206-C RECEIVER**
Airco beacon Receiver 200 to 500 Kc. Operates from 24V DC 1.5A, Continuous tuning, vol control, on-off switch, and phone jack. Very sensitive. Compact.
Complete with tubes, BRAND NEW... $12.50

---

**BC-604 FM TRANSMITTER**
20 to 27.9 Mc. Output approx 30 watts, 10 crystal controlled channels. Complete with tubes, BRAND NEW... $12.50

**ARC-721A Modern Q-5 Receiver 190 - 550 KHz... $10.95**
**ARC-720 540 - 1600 KHz Receiver with tuning graph... $15.95**
**R-4A/88-2 Receiver 234-258 Mc, 11 tubes, BRAND NEW... $8.95**
**BC-605 INTERPHONE AMPLIFIER, NEW $3.45 EXC. USED $1.95**
**TELEPHONE HANDSET, W.E. type... LIKE NEW $2.95**
**SCR-522 TRANSMITTER-RECEIVER, with 18 tubes, LIKE NEW $32.50**

---

**AM-300/AIC PUSHPLUG AMPLIFIER**
4-tube PP power amplifier with dynamotor, works on 28 VDC, Automatic gain control, Shpg wt 15 lbs., LIKE NEW... $3.95

**DUAL AMPLIFIER**
Has input circuits each feeding a single 6557G twin triode amplifier. Complete with 115V 60c power supply using 6X5GT rectifier.

**Brand New...** $5.95

**IP-69A/ALA-2 INDICATOR**
3" scope. Front panel controls: Vertical Pos., Horizontal Pos., Intensity, focus, gain, width, center freq, Pan. Operates on 115 V 380 to 1000 cps. Complete with tubes, LIKE NEW... $27.50

---

**TG-5B TELEGRAPH SET**
For code communications or code practice. Portable, with hinged lid, Two or more repeaters up to 25 miles apart, Bell coll system, 1000 cycle holler, key, headpiece, canvas case, book, Size 5-1/2"x5-1/2"x10", NEW... $8.95

**TELEPHONE TYPE RELAY**
Made by J.H. Bunnell, has adjustable sensitivity, 150 ohm coil, NEW... $3.45

---

**AN/APR-4Y FM & AM RECEIVER**
For Satellite Tracking. High precision lab instrument, for monitoring frequency and signal strength, 58 to 4000 Mc, in 3 tuning ranges. For 110 V 60 cycle AC, Built-in power supply. Original circuit diagram included. Check out. Per"fect. LIKE NEW... $88.50

All tuning units available for above, P.U.R.

---

**R-40/BCU-UHF FM RECEIVER**
200 to 250 Mc, Variable tuning, one band. 115/200 V 60 c. Complete with speaker, phone jack. Squelch circuit 2-1/2" meter for circuit testing: Includes 15 tubes: 8/6AG15, 902U, 5U4, 6/66, 6F5, 6N6, 6S5, 6A7, Size 20 x 9 x 16", Weight 75 lbs. NEW... $44.50

---

**TV-10 UHF TRANSVERTER**
28V DC Mode by Aircraft Radio Corp., Couples UHF Antenna to VHF transmitter and VHF receiver. Uses 6 tubes: 4/5/63 and 6/201. Includes 8 crystals ranging from 233.5 Mc to 937.5 Mc. Size: 11x4-1/2x4-4/5" wgt 5-1/2 lbs. LIKE NEW, with tubes and crystals... $9.95

---

**R-20 RECEIVER**
Made by Aircraft Radio Corp., works on 28 V, includes 4 tubes: 25/246, 12AX7, 12AT7, Size: 6-1/2x4-1/2x5-4/5", Weight 1.5 lbs. LIKE NEW... $7.50

---

**HANDMIDKE**
Rugged, heavy-duty carbon hand microphone with extra-talk switch, equipped with 4-ft cord & phone plug. SPECIAL, NEW box, $1.88 for $3.35

---

**2" DC VOLTMETER**
Mounted in 2-1/2" hole, Flange diameter 2-1/8". Two scales: 0-15 and 0-600, Calibrated for use on steel panel. Standard brand, SPECIAL, BRAND NEW, box... Each $1.75 for $3.00

---

**BC-733 RECEIVER**
Receives radio signals being transmitted by US satellite on approx, 108 Mc, AM, crystal-controlled on 6 preset freq. In 108.3 to 110.3 Mc range, Operates on 12/24 V DC & 220 VDC 80 Mc, Complete with 10 tubes. Can be converted to FM Receiver to 90 to 108 Mc, New... $5.95

**BC-732A Control Box for above, NEW... 1.75**

---

**T-41/A-APS - 18 TRANSMITTER**
ANTENNA 2 UNI. Designed for 115 V 800 to 1400 cps. Tubes included are the 1S6 and one 15R. Complete with shock mounts and blower motor, 6x18", NEW... $8.95

**BC-2232AX TRANSVERTER**
25 Watt, CW, MCW, Voice, Crystal control on 4 pre-selected channels, range 2000 to 5200 Kc by use of 3 plug units, Included. BRAND NEW... $27.50

---

**APN-1 FM TRANSEIVER**
400-450 Mc, Freq. modulated by moving coil transducer. Easily converted for radio control or 70 cma. Complete with 14 tubes, dyn. BRAND NEW... $9.95

**AM-26/AIC PHASE INVERTER AMP.**
4-tube pushpull power amplifier. Carbon mikes input, hi-lo imp. output. Works on 24VDC. Easily converted to 90-90 watt amplifier. Complete with tubes and dynamotor, LIKE NEW... $5.95

**WILLARD 2-VOLT STORAGE BATTERY**
Rated at 20 Amp-Hours, Model 20-10. Rechargeable. Compact non-spill construction, Lightweight polypropylene container, 246x1/2" x 1/2", Shipped dry, uses standard electrolyte. Weight 3 lbs. LIKE NEW... $2.79

**TERMS:** 25% Deposit with order, balance C.O.D. or - Remark - Restatement in full. Minimum order $50. F.O.B. NYC. Subject to prior sale and price change

---

**G&G RADIO ELECTRONICS COMPANY**
45-47 Warren St. (2nd Fl.) New York, N.Y. 10007 Ph. 212-267-4605
HAL 311BC ELECTRONIC KEYER
$53.00

THE most versatile keyer available. Send for full details on the HAL 311BC and the complete line of HAL electronic keyers. There is a model to fit your requirements and budget from $16.50 to $53.00. Shipping extra. Available in kit form for even greater value.

HAL TOUCHCODER II KIT
$55.00

HAL TOUCHCODER II KIT $55.00
Complete parts kit, excluding keyboard, for the W4UX CW code typewriter. All circuitry on one 3 x 6" G10 glass PC board. Plug-in IC sockets. Optional Contest I and RTTY features available. New keyboard under development.

HAL DIP BREADBOARD CARD
Drilled G10 glass PC board accepts 6 16 pin DIP IC's in plug-in sockets. Each IC pin fanned out to two pads. Plugs into standard 22 pin edge connector (.156" finger spacing). $5.50

DOUBLE BALANCED MODULATOR KIT
For the DBM in March 1970 Ham Radio 7/8 x 2" drilled G10 glass PC board 4 HP-2800 hot carrier diodes matched by HAL. 2 Indiana General CF102-G1 toroids. Wire and instructions included. $6.50

HAL 25KHz MARKER GENERATOR
Generates 50 KHz or 25KHz markers from 100 KHz oscillator (not supplied) Drilled 1 x 2" G10 glass PC board Strong markers to 148 MHz. Divides any signal up to 2MHz by 2 or 4. $4.25 kit form.

ORDERING INFORMATION
Postage is not included in the prices of HAL products. Please add 75¢ on small parts orders, and $2.00 on larger kits. Shipping is via UPS when possible, and via insured parcel post otherwise. Please give a street address. Catalog of all items 24¢ postage.

HAL DEVICES, Box 365H Urbana, IL 61801

HAL MAINLINE ST-6 RTTY TU
Complete parts kit for the W6FEC ST-6 now includes all parts except cabinet. Only 7 HAL circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. $135.00 kit. Wired units available. Shipping extra. Write for full details.

HAL RT-1 TU/AFSK KIT
$51.50

All TU and AFSK generator circuitry, including PS, on 3x6" G10 PC board. 850, 170, and CW ID shifts. Zener protected transistor loop switch. High and low impedance audio output. Price $45.00. Shipping extra. Write for full details.

HAL MAINLINE ST-5 RTTY TU
ST-5 kit now includes drilled G10 glass boards, custom Thordarson transformer, meter and metering components. Boards accept both round and DIP 709 IC's. $50.00. Less boards, meter & meter components $37.50. Boards only $6.00. Shipping extra.

HAL MAINLINE AK-1 AFSK OSC
HAL now offers a parts kit for the AK-1 AFSK osc. Drilled G10 glass PC board plugs into 12 pin edge connector for compatibility with the HAL ST-6, or for ease of use alone. Requires 12vdc. $27.50. Board only $4.00. Shipping extra.

HAL ID-1 REPEATER IDENTIFIER
TTI logic. Power line frequency counter for 3 minutes or less timing and control. Easily reprogrammable diode ROM uses only 27 diodes (depending on call) to send DE "any call!". Low impedance audio with volume and tone control. All circuitry including PS on small G10 glass PC board. Write for full details...... $75.00 Wired.

HAL MAINLINE ST-6 RTTY TU
Complete parts kit for the W6FEC ST-6 now includes all parts except cabinet. Only 7 HAL circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. $135.00 kit. Wired units available. Shipping extra. Write for full details.

HAL RT-1 TU/AFSK KIT
$51.50

All TU and AFSK generator circuitry, including PS, on 3x6" G10 PC board. 850, 170, and CW ID shifts. Zener protected transistor loop switch. High and low impedance audio output. Price $45.00. Shipping extra. Write for full details.

HAL MAINLINE ST-5 RTTY TU
ST-5 kit now includes drilled G10 glass boards, custom Thordarson transformer, meter and metering components. Boards accept both round and DIP 709 IC's. $50.00. Less boards, meter & meter components $37.50. Boards only $6.00. Shipping extra.

HAL MAINLINE AK-1 AFSK OSC
HAL now offers a parts kit for the AK-1 AFSK osc. Drilled G10 glass PC board plugs into 12 pin edge connector for compatibility with the HAL ST-6, or for ease of use alone. Requires 12vdc. $27.50. Board only $4.00. Shipping extra.

HAL ID-1 REPEATER IDENTIFIER
TTI logic. Power line frequency counter for 3 minutes or less timing and control. Easily reprogrammable diode ROM uses only 27 diodes (depending on call) to send DE "any call!". Low impedance audio with volume and tone control. All circuitry including PS on small G10 glass PC board. Write for full details...... $75.00 Wired.

HAL MAINLINE ST-6 RTTY TU
Complete parts kit for the W6FEC ST-6 now includes all parts except cabinet. Only 7 HAL circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. $135.00 kit. Wired units available. Shipping extra. Write for full details.

HAL RT-1 TU/AFSK KIT
$51.50

All TU and AFSK generator circuitry, including PS, on 3x6" G10 PC board. 850, 170, and CW ID shifts. Zener protected transistor loop switch. High and low impedance audio output. Price $45.00. Shipping extra. Write for full details.

HAL MAINLINE ST-5 RTTY TU
ST-5 kit now includes drilled G10 glass boards, custom Thordarson transformer, meter and metering components. Boards accept both round and DIP 709 IC's. $50.00. Less boards, meter & meter components $37.50. Boards only $6.00. Shipping extra.

HAL MAINLINE AK-1 AFSK OSC
HAL now offers a parts kit for the AK-1 AFSK osc. Drilled G10 glass PC board plugs into 12 pin edge connector for compatibility with the HAL ST-6, or for ease of use alone. Requires 12vdc. $27.50. Board only $4.00. Shipping extra.

HAL ID-1 REPEATER IDENTIFIER
TTI logic. Power line frequency counter for 3 minutes or less timing and control. Easily reprogrammable diode ROM uses only 27 diodes (depending on call) to send DE "any call!". Low impedance audio with volume and tone control. All circuitry including PS on small G10 glass PC board. Write for full details...... $75.00 Wired.

HAL MAINLINE ST-6 RTTY TU
Complete parts kit for the W6FEC ST-6 now includes all parts except cabinet. Only 7 HAL circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. $135.00 kit. Wired units available. Shipping extra. Write for full details.

HAL RT-1 TU/AFSK KIT
$51.50

All TU and AFSK generator circuitry, including PS, on 3x6" G10 PC board. 850, 170, and CW ID shifts. Zener protected transistor loop switch. High and low impedance audio output. Price $45.00. Shipping extra. Write for full details.

HAL MAINLINE ST-5 RTTY TU
ST-5 kit now includes drilled G10 glass boards, custom Thordarson transformer, meter and metering components. Boards accept both round and DIP 709 IC's. $50.00. Less boards, meter & meter components $37.50. Boards only $6.00. Shipping extra.

HAL MAINLINE AK-1 AFSK OSC
HAL now offers a parts kit for the AK-1 AFSK osc. Drilled G10 glass PC board plugs into 12 pin edge connector for compatibility with the HAL ST-6, or for ease of use alone. Requires 12vdc. $27.50. Board only $4.00. Shipping extra.

HAL ID-1 REPEATER IDENTIFIER
TTI logic. Power line frequency counter for 3 minutes or less timing and control. Easily reprogrammable diode ROM uses only 27 diodes (depending on call) to send DE "any call!". Low impedance audio with volume and tone control. All circuitry including PS on small G10 glass PC board. Write for full details...... $75.00 Wired.

HAL MAINLINE ST-6 RTTY TU
Complete parts kit for the W6FEC ST-6 now includes all parts except cabinet. Only 7 HAL circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. $135.00 kit. Wired units available. Shipping extra. Write for full details.

HAL RT-1 TU/AFSK KIT
$51.50

All TU and AFSK generator circuitry, including PS, on 3x6" G10 PC board. 850, 170, and CW ID shifts. Zener protected transistor loop switch. High and low impedance audio output. Price $45.00. Shipping extra. Write for full details.

HAL MAINLINE ST-5 RTTY TU
ST-5 kit now includes drilled G10 glass boards, custom Thordarson transformer, meter and metering components. Boards accept both round and DIP 709 IC's. $50.00. Less boards, meter & meter components $37.50. Boards only $6.00. Shipping extra.

HAL MAINLINE AK-1 AFSK OSC
HAL now offers a parts kit for the AK-1 AFSK osc. Drilled G10 glass PC board plugs into 12 pin edge connector for compatibility with the HAL ST-6, or for ease of use alone. Requires 12vdc. $27.50. Board only $4.00. Shipping extra.

HAL ID-1 REPEATER IDENTIFIER
TTI logic. Power line frequency counter for 3 minutes or less timing and control. Easily reprogrammable diode ROM uses only 27 diodes (depending on call) to send DE "any call!". Low impedance audio with volume and tone control. All circuitry including PS on small G10 glass PC board. Write for full details...... $75.00 Wired.
THE ANNUAL IOWA 75 meter phone net picnic will be held on Sunday, August 15, 1971 at River- view Park in Marshalltown, Iowa. All amateurs, of course, are cordially invited. There will be a swag table and nice prizes to be given away. The festivities will start with a pot luck dinner at 12 noon with the remainder of the festivities occurring Sunday afternoon.

FOR SALE: Marker Luxury 2-meter FM transceiver $100 under Drake price. Accessories: Crystals for 34/94. Will ship express or bus COD. $230. No trades. B. Olson, Box 86, Von Ormy, Texas 78073.

12th NEW JERSEY QSO PARTY. The Englewood Amateur Radio Association, Inc. invites all amateurs to take part. From 1900 GMT Saturday, August 21 to 0600 GMT Sunday, August 22 and from 1200 GMT Sunday, August 22 to 0000 GMT Monday, August 23. Phone and CW are same contest. A station may be contacted once on each band. Phone and CW are considered separate bands. New Jersey stations may work other New Jersey stations. Suggested frequencies: 1810, 3555, 3740, 3930, 7060, 7275, 14075, 14280, 21100, 21375, 28800 kHz, 5050 kHz, 144-146 MHz. Suggest phone activity on the EVEN HOURS. Exchanges consist of QSO number, RST and QTH (ARRL Section or country). Stations will send county for their QTH. Certificates will be awarded to the first place station in each N.J. county, ARRL section and country. Winners of certificates will be announced by the ARRL W4EUK. The certificate will be awarded when four or more logs are received. Novel and technical certificates will also be awarded. Logs containing names of others will be sent to Englewood Amateur Radio Association, Inc., 303 Tenafly Road, Englewood, New Jersey 07631. A size #10 SASE should be included for results.

TRADE: GT550 with AC supply, vox, and calibrator all in perfect condition. Interested in T4XK or SB220 or best cash offer. Jim Fleming, 5728 Brynmawr, Chicago 60631. 775-8179.

FOR SALE: HOMEBREW 50w. CW XMR 80-10 mtrs w/Heath VFO, RC bridge and lots of good junk. $100. F. Redburn, 505 Kenninston Dr., #101, Austin, Texas 78752.

THE NORTH TEXAS REPEATER ASSOCIATION is hosting the summer meeting of the Texas VHF-FM Society on Saturday and Sunday, 14 and 15 August. The meeting will be held at the Citibulla Inn, US Highway 121, Plano, Texas 75093. Prizes, Displays, Technical Sessions, XYL program. No registration fee. Just pay your own lodging, meals and entertainment. For information contact George Lyle, K7ZAU, 1047 Mark Way, Carson City, Nevada 89701.

THE ANNUAL SIERRA HAMFEST will be held on August 14, 1971 at the California Building in Idledale Park, Reno, Nevada. For more information contact George Yule, K7ZAU, 1047 Mark Way, Carson City, Nevada 89701.

MOTOROLA 80D — 12v. Crystalled up and operating 146.94-146.96. 2-freq. xmit, accessories. George Evans, K2SLI, 17 George, Freehold, NJ. 201-431-0649

THE AMATEUR RADIO CLUBS of New Mexico will sponsor the New Mexico HAMVENTION 1971 on September 17, 18 and 19, 1971. Convention head- quarters will be the Sheraton Inn, 100 North Highway 66, Albuquerque, New Mexico. The Program: Antenna Session, SB5, LABER Communicati ons, CW, SSB, 23cm, Traffic, VHF/FM, Luncheon & Fashion Show, AEC/RACES, MARS, Manufacturers Displays, Banquet with top speakers. Many prizes; Flea Market/Swapfest all day Sunday. Talk-in Frequencies — 3940 — 7255 146.34/146.94 Pre-registration — $8.50, includes banquet meal. Contact: New Mexico HAMVENTION, Box 14381, Albuquerque, NM 87111.

MECHANICAL FILTERS: 455 Khz. 2.1 Khz $18.95, 300 Hz $22.95. J. A. Fredricks, 314 South 13th Ave., Yakima, Washington 98902.

TELL YOUR FRIENDS about Ham Radio Magazine.
Many thousands of you have become very familiar with the various Radio Society of Great Britain books and handbooks, but very few of you are familiar with their excellent magazine, *Radio Communication*.

It includes numerous technical and construction articles in addition to a complete rundown on the month's events in amateur radio. Surely a most interesting addition to your amateur radio activities.

We can now offer this fine magazine to you along with the other advantages of membership in the RSGB (such as use of their outgoing QSL Bureau) for $9.60 a year.
THE LINCOLN, NEBRASKA Amateur Radio Club will operate a special prefix amateur radio station using the call KQNEB. Operations will commence at 2100 GMT September 1, 1971 and will be continuous 24 hours a day through 0500 GMT September 6, 1971. Transmitters will be on 10, 15, 20, 40 and 80 meters, both CW and SSB. DX contacts will be QSLed via Bureaus. Statewide contacts must be made with SASE to WOYQ, Box 5006, Lincoln, Nebraska 68505. As with past operations of the Club, a special QSL card will be used.


THE NORTH ALABAMA HAMFEST will be held on 15 August in the cafeteria of John C. Calhoun Technical and Junior College located north of Decatur, Alabama on U.S. Highway 31.

WANT: CENTRAL ELECTRONICS 10A or 10B Exciters. Ken Cornell, W2IWB, P. O. Box 721, Westfield, N. J. 07091.

VHF NOISE BLANKER — See Westcom ad in Nov., Dec. '70 and Mar. '71 Ham Radio.

OLD TIME RADIO SHOWS. SASE. Box 724, Redmond, Washington 98052.

“DON AND BOB” NEW GUARANTEED GOODIES. Monarch KW SWR Relative Power Dualimeter, Monarch Bridge 14.95 plus postage handling 1.50; Motorola HEP170 Epoxy Diode 2.5A/1000PV 39c; Anamphol PL259 SO239 3.95/10; Ham-M Rotor 99.00; TR-44 59.95; Quote new discontinued tubes; Industrial surplus list; Quote Drake, Galaxy, Hallicrafters, Mosley, Tri-Ex, 2 meter transceivers. Tempo, Kenwood write specifications. Prices collect. Mastercharge, BankAmericard. Warranty guaranteed. Mason Electronics, 1508 McKinney, Houston, Texas 77002.

LOOKING FOR FULL-TIME EMPLOYMENT? If you’re a self-starter able to sell excellent Electronic Courses, there are jobs available throughout America and Canada. Write to Bill Welsh (W6DDB), 234 S. Orchard, Burbank, CA 91506.

WARREN ARA 14th HAMFEST — Still the friendliest. Sunday, August 22, new site: Yankee Lake, on Ohio Rt. 7, five miles north I-80. Picnic, swimming, playground. Prizes, giant free flea market, displays. For details & map, send card: Hamfest, Box 805, Warren, Ohio 44480.

THE DES MOINES Radio Amateur Assn., has attempted a special event at the lowa State Fair Aug. 20-29 with the station calling KIOISF or WIOISF. The station will be operating August 20-29.

DON’T BUY QSL CARDS from anyone until you see my free samples. Fast service. Economical prices. Little Print Shop, Box 9848, Austin, Texas 78757.

THE PUGET SOUND COUNCIL of Amateur Radio Clubs will issue an operating achievement award signed by Governor Daniel J. Evans, for contacts made during the Washington State Amateur Radio Week, September 4th to 12th, 1971. Out-of-state amateurs must work ten Washington stations, and in-state amateurs must work twenty other Washington stations during this week. Send list of stations worked, their locations, dates of contacts, and your name, call, and address to: The Puget Sound Council of Amateur Radio Clubs, 12306 80th Avenue East, Puyallup, Washington 98371. An SASE would be appreciated.

NEW — for 2M FM
Tone Burst Encoder for Reliable Repeater Access
- One, two or six frequency models
- Fully automatic operation
- Screwdriver adjustable from 1500-2600 Hz
- 12 VDC powered — no batteries
- MIL Spec design, construction and performance

Priced from $26.95
send QSL for spec sheet

NEW — for RTTY
Phase Locked Loop Terminal Unit
- Copies shifts from 100 to 1000 Hz automatically
- Auto-track for drifting signals
- Enters "mark-hold" when signal fades
- Input tone range switchable to operate with SSB transceiver audio
- Autostart and selective call available
Write today for detailed specifications

WCI
PO Box 17, Schaumberg, Ill. 60172

. . . THE BEST
2 METER CONVERTER

Model 407
$42.95
pdp.

144-146 MHz in. 28-30 MHz out
or 146-148 MHz with a second crystal
available for $5.95 each

A full description of this fantastic converter would fill this page, but you can take our word for it (or those of thousands of satisfied users) that it's the best. The reason is simple — we use three RCA dual gate MOSFETS, one bipolar, and 3 diodes in the best circuit ever. . . Still not convinced? Then send for our free catalog and get the full description, plus photos and the schematic.

Can't wait? Then send us a postal money order for $42.95 and we'll rush the 407 out to you. . .

NOTE: The Model 407 is also available in any frequency combination up to 450 MHz (some at higher prices) as listed in our catalog. New York City and State residents add local sales tax.

VANGUARD LABS
Dept. R, 196-23 Jamaica Ave., Hollis, N.Y. 11423

More Details? CHECK-OFF Page 94
**FM RINGO**

3.75 db GAIN
AR-2 – $12.50

WORLD'S BEST VHF FM ANTENNA, IN STOCK AT YOUR LOCAL DISTRIBUTOR.

---

**KENWOOD**

“The Value Line”

Communications World, Inc. is pleased to announce that it has been accepted by Henry Radio to sell and service this fine product. Before you buy your next piece of equipment check with us on this best of buys in amateur equipment.

Communications World, Inc.
4788 State Road
Cleveland, Ohio 44109
216-398-6363
WANTED R390, R390A, R389, 511A, 5151. Racal, Nems, Clarke, Marconi receivers. SWRC, P. O. Box 10048, Kansas City, Missouri 64111.

QSLs, SECOND TO NONE. Same day service. Samples: R. Ray, K7HRL, Box 331, Clearfield, Utah 84015.

ORIGINAL EZ-IN DOUBLE HOLDERS display 20 cards in plastic, 3 for $1.00, 10 for $3.00 prepaid. Guaranteed. Free sample to dealers. Tepabaco, John K4NMT, Box 198R, Gallatin, Tenn. 37066.

ASK FOR FREE LIST of used Ham gear or for prompt personal attention on any new gear. Mail your order to Van Sickler, W9JK, Indianapolis, Indiana 46205. 40 years experience.

GALAXY FM-210 transceiver, two AC supplies. $210.00.

ASK FOR FREE

R390.

ORIGINAL EZ-IN DOUBLE HOLDERS display 20 cards in plastic, 3 for $1.00, 10 for $3.00 prepaid. Guaranteed. Free sample to dealers. Tepabaco, John K4NMT, Box 198R, Gallatin, Tenn. 37066.

ASK FOR FREE LIST of used Ham gear or for prompt personal attention on any new gear. Mail your order to Van Sickler, W9JK, Indianapolis, Indiana 46205. 40 years experience.

GALAXY FM-210 transceiver, two AC supplies. $210.00.

ASK FOR FREE

R390.

ORIGINAL EZ-IN DOUBLE HOLDERS display 20 cards in plastic, 3 for $1.00, 10 for $3.00 prepaid. Guaranteed. Free sample to dealers. Tepabaco, John K4NMT, Box 198R, Gallatin, Tenn. 37066.

ASK FOR FREE LIST of used Ham gear or for prompt personal attention on any new gear. Mail your order to Van Sickler, W9JK, Indianapolis, Indiana 46205. 40 years experience.

GALAXY FM-210 transceiver, two AC supplies. $210.00.

ASK FOR FREE
GEM-QUAD FIBRE – GLASS
ANTENNA FOR 10, 15, and 20 METERS.

Two Elements $107.00
Extra Elements $60.00 ea.
Submit Payment with Order
Shipped Freight collect.
Price includes
Canadian Federal Sales Tax
or U.S. Customs Duty.

KIT COMPLETE WITH
• SPIDER
• ARMS
• WIRE
• BALUN KIT
• BOOM WHERE NEEDED

SEE OUR FULL PAGE IN MAY ISSUE

Buy two elements now – a third and fourth may be added later with little effort.

Enjoy optimum forward gain on DX, with a maximum back to front ratio and excellent side discrimination.

Get a maximum structural strength with low weight, using our “Tri-detic” arms.

MANITOBA DESIGN INSTITUTE
AWARD WINNER

20 Burnett Avenue, Winnipeg 16, Manitoba, Canada

A New Magazine?

Not really. New in the U.S.A. perhaps, but very well known in Great Britain and now being offered to you here.

RADIO CONSTRUCTOR is almost exclusively construction material. Clearly written, concise articles give you full details on:

- Audio Construction Projects
- Receiver Construction Projects
- Transmitter Construction Projects
- Test Equipment Projects
- Radio Control Projects
... and much more

Try a subscription to this interesting magazine, we are sure that you will not be disappointed.

ONE YEAR SUBSCRIPTION — $6.50

Write
RADIO CONSTRUCTOR
Greenville, N. H. 03048

USED TEST EQUIPMENT

All checked and operating unless otherwise noted, FOB Monroe. Money back (less shipping) if not satisfied.

<table>
<thead>
<tr>
<th>Fluke Monotronics 207-1 Precision VLF Receiver-Comparator transistorized</th>
<th>$640</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR720A-Freq. Mtr. 10-300mHz</td>
<td>$72</td>
</tr>
<tr>
<td>GR821A-Twin-T Imp. Bridge</td>
<td>$235</td>
</tr>
<tr>
<td>GR1603A-ZY bridge</td>
<td>$176</td>
</tr>
<tr>
<td>EG&amp;G-Millimeter 707-Lab scope to 1000mHz</td>
<td>$525</td>
</tr>
<tr>
<td>HP120AR-200kHz scope</td>
<td>$135</td>
</tr>
<tr>
<td>HP175A-50kHz scope-main frame only</td>
<td>$450</td>
</tr>
<tr>
<td>HP524B-10mHz freq counter</td>
<td>$325</td>
</tr>
<tr>
<td>HP524B-W/Plug-in to 100mHz</td>
<td>$385</td>
</tr>
<tr>
<td>HP525A-10-100mHz plug-in for above</td>
<td>$115</td>
</tr>
<tr>
<td>HP525B-100-220mHz plug-in for above</td>
<td>$225</td>
</tr>
<tr>
<td>HP525C-100-500mHz plug-in for above</td>
<td>$225</td>
</tr>
<tr>
<td>HP526B-Time interval plug-in for above</td>
<td>$65</td>
</tr>
<tr>
<td>HP608A-10-500mHz stand sig gen</td>
<td>$400</td>
</tr>
<tr>
<td>Meas 82-20Hz-200kHz, 80kHz-50mHz stand sig gen</td>
<td>$275</td>
</tr>
<tr>
<td>NE Eng 14-20Hz-10mHz freq counter (as is less time standard)</td>
<td>$180</td>
</tr>
<tr>
<td>NE Eng 14-20C-complete, checked</td>
<td>$295</td>
</tr>
<tr>
<td>NE Eng 14-20C-W/plug-in to 100mHz</td>
<td>$355</td>
</tr>
<tr>
<td>NE Eng 14-21C-10-10mHz conv for avb</td>
<td>$114</td>
</tr>
<tr>
<td>NE Eng 14-22D-100-220mHz for avb</td>
<td>$135</td>
</tr>
<tr>
<td>NE Eng 14-24C-Time interval conv for avb</td>
<td>$65</td>
</tr>
<tr>
<td>Polaroid R microwave rcvr (plug-ins avail)</td>
<td>$275</td>
</tr>
<tr>
<td>Tektronix 5132-20mHz scope</td>
<td>$275</td>
</tr>
<tr>
<td>Tektronix 517A-Hispeed scope</td>
<td>$545</td>
</tr>
<tr>
<td>FR 4/U Freq. Mtr. 125kHz-200Hz</td>
<td>$125</td>
</tr>
<tr>
<td>Servo Corp. Servoscope 1100 C meter</td>
<td>$280</td>
</tr>
<tr>
<td>TS810/U Scope calibrator</td>
<td>$72</td>
</tr>
<tr>
<td>URM25E-5kHz-50mHz stand sig gen</td>
<td>$215</td>
</tr>
<tr>
<td>USM50-20mHz time base scope</td>
<td>$145</td>
</tr>
<tr>
<td>USM105A-Mil version HP160 scope</td>
<td>$550</td>
</tr>
</tbody>
</table>

(Send SASE for complete list)

GRAY
P. O. Box 941 Monroe, MI 48161
Specializing in used test equipment

GET YOUR NEW ISSUES NOW!

Over 285,000 QTHs in the U.S. edition $8.95
Over 165,000 QTHs in the DX edition $6.95

NEW EDITION EVERY:
MARCH 1 – SEPT. 1
JUNE 1 – DEC. 1

These valuable EXTRA features included in both editions!

- QSL Managers Around the World!
- Census of Radio Amateurs throughout the world!
- Radio Amateurs’ License Class!
- World Prefix Map!
- International Radio Amateur Prefixes
- Prefixes by Countries!
- Zips on all QTH’s!
- A.R.R.L. Phonetic Alphabet!
- Where To Buy!
- Great Circle Bearings!
- International Postal Information!
- Plus much more!

See your favorite dealer or order direct (add 25¢ for mailing in U.S., Possessions & Canada. Elsewhere add 50¢).

WRITE FOR FREE BROCHURE!
TWO METER FM HQ
prompt delivery on the
NEW
DRAKE
2-METER XCVRS
ML/2F
12 channels
over 10 watts
HOME or MOBILE
117v AC or 12v DC
$329.95
TR-22
6 channels
over 1 watt
PORTABLE or MOBILE
BATTERY or 12v DC
$199.95

ALSO COMPLETE LINES HAM SUPPLIES — ALL BRANDS — NEW — USED TRADES — TERMS. Xcvrs, Rcvrs, Xmtrs, Linears, Towers, Beams, Antennas, Accessories, Microphones, Police/Fire Monitors, Tubes, etc., etc.
HAN — CB — MARINE — TWO-WAY — METAL-LOCATORS
SSB — CW — AM — FM — RTTY — SSTV — CTV — MATV
FOR FREE CATALOGS, WHOLESALE PRICES and USED GEAR LIST
WRITE Chuck, WB8UCG
ELECTRONIC DISTRIBUTORS, INC.
MIDWEST HAM HEADQUARTERS FOR OVER 32 YEARS!
1960 PECK ST., Tel. (616) 726-3196, MUSKEGON, MICH. 49441

B A R R Y

6.3 VAC @ 2A fil. xfrmr. (115 VAC) .......... $1.95
833/833A tube socket. Johnson #212 .......... $12.95
DYCOMM "Block Booster" FM (2 mtr) amplifier,
50 watt output. 12 volt DC ................. $69.95
DYCOMM "Brick Booster" 2 meter FM amplifier,
12 watt output. 12-volt input. 12 VDC ....... $69.95

30 AMP filament choke. ................. $5.90

SILICON BRIDGE RECTIFIER. Tested at 6000
volts and 1 Amp. (4 separate rectifiers mounted
on Nylon card) 2 oz. .......................... Sale $5.95
DRAKE ML-2F FM MOBILE/BASE ........... $329.95
DRAKE TR-22 FM PORTABLE/BASE .......... $199.95
4" sq. PM Speaker, 40, 2 watts, new ............. 60c
1 Amp SILICON DIODES: 400 PIV @ 12v; 600
PIV @ 15v; 800 PIV @ 20v; 1000 PIV @ 25v

AUTOXMF: 115 to 230 VAC input
output: 350 VAC and 7 volts AC ............. $1.95

Deluxe TRANSCO SP4T COAXIAL
SWITCH carries 2KW PEP @
30MHz. Good to 3000 Mhz. New, Sealed ........ $17.50

VS-2 VACUUM RELAY by
Elmac/Bendix. Easily switches
2KW up to 15kV. Coll: 24 VDC ......... $9.95

WATERS MODEL 346 Nuverter. 2 & 6 M VHF
converter. New. Orig. $175.00 net. Sale $80.00

RCA 1000.000 kHz CRYSTAL .......... Only $3.50
JOHNSON VIKING RANGER — 10 through 160
meters (also 11 meters). XInt/lab ok .......... $125.00
LAFAYETTE HA-350 receiver. 10 thru 80 & WWV.
SSB (with mech. filter)/AM/CW .......... $95.00
LAFAYETTE 6 meter HA-460 Transceiver, 115
VAC or 12 VDC. Mint .......... Complete .......... $95.00
HAMMARLUND HQ-110 — Ham band receiver,
6 thru 160, w/clock. Good/lab ok .......... $95.00
YAESU-FLD400 Transmitter, NEW .......... $295.00
EICO 722 Variable frequency oscillator. Ready
to operate .......... $49.50
SB2-LA 1 kW Linear amp. with built in power
supply. Mint .......... $175.00
COLLINS 352D-2 Mobile Mount for KWM-2.
Excellent .......... $135.00
COLLINS PM-1 (12VDC P.S. for KWM2 (2A) etc.
XInt .......... $125.00

We will demonstrate Alpha Seventy Linear ...
We are factory export distributor for E.T.O./
Alpha.

New Items arrive daily. Check with us or come
in for a pleasant visit. Large stocks of famous
brand new and lab-checked trade-ins.

NEW! Pearce-Simpson’s GLADDING 25 — Six
channel two meter FM Transceiver. Full 25 watts
output (1 watt on Lo). Write or phone.

CASH PAID .... FAST! For your unused TUBES,
Semic conductors, RECEIVERS, VAC, VARIABLES,
Test Equipment, ETC. Write or call Now! Barry,
W2LN! We Buy!
☐ Send $5 for 104 page catalog #20.

BARRY ELECTRONICS CORP.
DEPT. H-8 — PHONE A/C 212-925-7000
512 BROADWAY, NEW YORK, N. Y. 10012

More Details? CHECK—OFF Page 94
august 1971 89
2 METER FM TRANSMITTER KIT
5 Watts — 4 Freq.

FEATURED: Step-by-step instructions . Glass epoxy P.C. board . 16 Transistors . 9 Diodes . Plug-in crystals . Separate oscillator for each frequency . only 1 amp. @ 13.6V for 5 watts (typical) output . ±10 Khz Dev.

PRICE — $59.95
(less xtal & accessories)

Price is F.O.B. Wood Dale, Ill.
Ill. Residents add 5% Sales Tax

RMV ELECTRONICS
BOX 283, WOOD DALE, ILL. 60191

ANTENNA MATCHING TRANSFORMERS
• 50 ohm co-ax to 50 ohm balanced load (for doublets & inverted vee's) $14.95
• 50 ohm co-ax to 75 ohm balanced load (for single feed three band quad) $18.95
• 50 ohm co-ax to 75, 120, and 140 ohm load (for single feed three band quad) $14.95
• Other impedance ratios available on request

All units are rated at full legal power and shipped post paid. Calif. residents add 5% sales tax.

H & H ENGINEERING
P. O. Box 68, La Mirada, Calif. 90638

CONNECTICUT HAMS
Visit Roger Miner's Surplus Electronics, 246 Naugatuck Ave., Milford, Conn. Ph. 877-0555. Nights 7 pm to 10 pm and all day Saturday.

For Sale: Johnson Invader 2000 — $500.00, Heath SB-200 — $165, NCX-3 — $175 w/ps, DX-2O — $20.00, Super Pro — $100.00, Swan 250c w/ps — $385.00, Collins 75S1 w/nbr — $300.00, HEWLETT-PACKARD 202c audio osc. — $30.00, 205ah audio osc. — $40.00, 450a wide band amp. — $20.00, 460b wb amp. — $25.00, 521 freq. counter — $150.00, 522b counter — $180.00, 415b swr meter — $40.00. Thousands of parts. High power amp. parts, power supplies, etc., come see us.

The Roger X Miner
SURPLUS ELECTRONICS COMPANY
246 NAUGATUCK AVENUE • MILFORD CONNECTICUT 06460

WE PAY HIGHEST PRICES FOR ELECTRON TUBES AND SEMICONDUCTORS
H & L ASSOCIATES
ELIZABETHPORT INDUSTRIAL PARK
ELIZABETH, NEW JERSEY 07206
(201) 351-4200

DO YOU NEED CASH?? THEN WRITE ME GIVING LIST OF GOOD AMATEUR GEAR YOU WANT TO SELL: WE NEED GOOD NOVICE XMTRS., RECEIVERS, OR WHAT HAVE YOU: WANTED COLLINS EQUIP. KWM-2, "S LINE" LINEARS, ETC.

USED, GUARANTEED EQUIPMENT FOR SALE OR TRADE

COLLINS:
75A2 — VRY GUD COND. .... $199.00
75A4 — VRY GUD COND. .... $345.00
75A4 (New PTO) EX. COND. ... $425.00

JOHNSON:
INVADER 200, Mint. ........... $225.00

SWAN:
240 & TCU, Mint. ........... $325.00

HICKOK:
Model 505A Scope, Exc. .......... $95.00

We have more gear than we can list here, write for up-to-date list and prices. New equip. Galaxy, Swan, Drake, Regecy, HR-2, Mosley, Hy-Gain, New-Tronics, Cush-Craft. We are also dist. for CB radios, new and used. Let us know your needs in amateur and CB equipment.

BOB'S DISCOUNT ELECTRONICS
720 N Hudson, Oklahoma City, Okla. 73102

(405) 232-1384

More Details? CHECK-OFF Page 94
WANTED! DRAKE R-4A
REWARD: $295.00*
trade allowance on new R-4B at $475.00

R-4B Receiver
Your inquiries invited on this or any other fine Drake equipment.
Mention this ad and we will prepay the freight to anywhere in the U.S.A.

L.A. Electronix Sales
2344 S. Crenshaw Blvd.
Torrance, California 90505
213-534-4456

IN DUAL-IN-LINE PACKAGES

DIGITAL TTL
7400 4-2 input NAND 35 7410 3-3 input NAND 35
7402 4-2 input NOR 35 7420 2-4 input NAND 35
7408 Hex Inverter 39 7446 2-4 input Buffer 35
7411 BCD-to-Decimal Decoder/Driver 2.60
7424 BCD-to-Decimal Decoder 1.79
7427 BCD-to-7-Segment Decoder/Driver 1.79
7451 2-2-wide 2-input AND OR INVERT 35
7454 1-4-wide 2-input AND OR INVERT 35
7472 JK MS Flip Flop 50 7475 DualLatch 1.35
7473 Dual JK Flip Flop 70 7476 Dual JK Flip Flop 80
7483 Decade Counter 1.40 7487 Dual JK Flip Flop 75
7491 4-Bit Binary Counter 1.40
7495 4-Bit L/R Shift Register 1.50

DIGITAL DTL
930 2-4 input NAND 35 9303 2-4 input Exor 35
936 Hex Inverter 39 456 4-2 input NAND 35
962 5-3 input NAND 9095 Dual JK Flip Flop 67
945 RS JK Clocked Flip Flop 50

LINEAR IC's
7413 OP AMP, commonsource 6V-15V TO-5 92c
7096 OP AMP DIP 67c TO-5 75c
Discounts up to 25% available on large IC orders. Dues of other parts available. Send postcard for catalog. Orders less than $10.00 and 50c post & handling. Above $10.00 post.

DIGI-KEY
Box 126, Thief River Falls, Minnesota 56701

IS IT EASY TO LEARN THE CODE?
Frankly, no. Neither was it easy to learn how to read without two things: Proper instruction, and practice. CODEMASTERTapes, proven in over five years of sales of thousands of tapes all over the world, give you that essential instruction. No other teaching system offers you a more proven method, more accurate sending, more complete guidance. Select your CODEMASTERTapes below!

CM-1: For the beginner. A complete course of instruction is on the tape. Practice material at 5, 7, 9 WPM. Prepared for you for Novice exam. Includes code groups and punctuation.

CM-1½: An intermediate tape, especially for General Class exam study. No instruction; just practice. 3/4 hr. 11 WPM: 1 hr 14 WPM. 3/4 hr at 17 WPM. Includes codes and groups and straight text.

CM-2: For Extra-Classic class study. Mostly straight text; some code groups. 3 hours at 20 WPM; 2 1/2 hour each at 25 and 30 WPM. For real QRO, play this tape at twice speed!

MORE DETAILS? CHECK-OFF PAGE 94

More Details? CHECK-OFF Page 94

August 1971
CLODEDUTI OVERHAULED & CERTIFIED COUNTERS
Solid-State 220 MHz: CMC 737CU, 7 nixies, plus 525A & B. Light & compact. $575.00
510 MHz: Substituted for 2SC5 for 525B, add $50.00
10 Hz-15 GHz: Read freq. on 7 DCU’s no algebra! Beckman
7570/7580 combo. 750.00
1 MHz Universal, 6 DCU’s, Beck., or H.P. 195.00
1 MHz Universal, 6 Nixies. Hewi-Pack. 105.00
2 MHz Universal, 6 DCU’s, Beckman. 105.00
Solid-State 5 Nixie .3 MHz, H.P. 5232L. 275.00
Solid-State 5 Nixie 2 MHz, H.P. 5233L. 295.00
Solid-State Preset & Freq., H.P. 5234L. 275.00
8 Ib 20 MHz solid-state, Simpson #2725. 250.00
#2950A Hewi-Pack 15 GHz Transfer Osc. $220.00

BRAND NEW SOLID-STATE SCOPE BARGAINS:
We are now the Distributor for Leader Instr. Corp.
QUALITY-CONTROLLED imports. Warranty is 2 years on parts, 6 mos. on labor. We pay the shipping to your door.
20-34 NAVY PORTABLE 4 MHz SCOPE
AN/USM-32: 10 Hz to 4 MHz ±2 db. Line 116v, 50-400 Hz. 3WP1 CR tube with rectangular mask & graticule. Sensit. 40 mV/m/cm & up, and includes calibrator. 350 mV sec video delay line. Input 1 meg, 28 pf. Swept triggered by signal, 3/4 usec/cm & up. 5 choices Z-axis Markers for exact cal. W/schem. dwg. & op. instructed. GR $129.50
(Open Box, used color; grid not over $50.)

TEKT. & WEHELETT-PACKARD SCOPE BARGAINS:
See our June ad for listing. ADD: Tekt. 515A at $395.00 and 543B at $595, both exc. cond.; and 661 with 451 and 573 already overhauled & calib. at only $40.00

REDUCED SUMMER RADIO-RECEIVER PRICES!
Take advantage of the usual summer sales slump and some real good buys we made. Start a Christmas Lay-Away purchase if you wish. We will hold them at no charge for holding. Every receiver put through a VERY competent shop, aligned, grid 199% perfect, and cleaned. SP-600-JX, double-conversion 540 kHz continues to 54 MHz, plus crystal control, if you wish, for $1099.00. In cabinet, $1299.50. Less cabinet but with top and bottom conversion, $275.00. R930/URR, triple-conversion, 500 kHz to 32 MHz with precision digital tuning & crystal zero-beat and corrector each 100 KHz...only $595.00. R940/URR adds the sharper CW selectivity of mechanical filters, only $795.00. Dual-Diversity TTY converter AN/URA-8 in very exc. cond. grid 100% OK only $275.00

If you don't see it here, ask for it!
Or ask for the KIND of material you want. But don't ask for a general catalog... we believe that is nonsense in surplus...we get new things in almost every day! WE ALSO BUY! So tell us what you have, condition, and your asking price.

R. E. GOODHEART CO. INC.
Box 1220-HR, Beverly Hills, Calif. 90213
Phone: Area Code 213, Office 277-5707

A NEW TRANSMATCH - MODEL UT-1
A New Universal Transmatch from the ANTEC COMPANY
- 80 thru 10, including all MHz
- with use all antenna-feedline connection
- freq. above 3.5 MHz
- 2kw. PEP. SWR 1.1, all freq.
- provides 50-20 Ohm passive load
- fully guaranteed, made in U.S.A.
- available as unitized 10 module transmatch
- high output
- complete assembly
- uses standard 3/4" mounting to suit equipment
- 115 VAC, 60 CPS, 20 CFM, 2400 RPM. Special $4.95.
- Free Potting Compound Kit with each order.

CATALOGUE 100
BOB-FRANK ELECTRONICS
407 Ritter Rd. • Harrisburg, Pa. 17109

STUD NUT - THE NEW
united fastener for rapid and convenient mounting of threaded-stud, solid-state devices.

Replaces 5 separate items of hardware now required for mounting SCR's, Zeners, Diodes and Power Transistors.

PROVIDES
- Exact stud centering for maximum voltage insulation
- Stud isolation from mounting surface
- Locking action
- Electrical connection to device stud

Rated to 30 Amperes, continuous. Mounted with std. 7/16" hex-nut driver.

Supplied with Mica washer for COMPLETE mounting kit for #10-32 threaded stud devices.

Package of 4 STUD-NUTS & WASHERS - $1.00
Package of 24 STUD-NUTS & WASHERS - $5.00

SCF Corp. P. O. Box 999, Highstown, N. J. 08520

Radio Amateurs Reference Library of Maps and Atlas

WORLD PREFIX MAP - Full color, 40" x 28", shows prefixes on each country... DX zones, time zones, cities, cross referenced tables...

postpaid $1.25

RADIO AMATEURS GREAT CIRCLE CHART OF THE WORLD - from the center of the United States! Full color, 30" x 25", listing Great Circle bearings in degrees for 15 major U.S. cities, Boston, Washington, D.C., Miami, Seattle, San Francisco & Los Angeles...

postpaid $1.25

RADIO AMATEURS MAP OF NORTH AMERICA - Full color, 30" x 25" - includes Central America and the Caribbean to the equator, showing call areas, zone boundaries, prefixes and time zones, FCC frequency chart, plus informative information on each of the 50 United States and other Countries...

postpaid $1.25

WORLD ATLAS - Only atlas compiled for radio amateurs. Packed with world wide information - includes 11 maps, in 4 colors with zone boundaries and country prefixes on each map. Also includes a polar projection map of the world plus a map of the Antarctica - a complete set of maps of the world. 20 pages, size 8 1/4" x 12"...

postpaid $2.00

Complete reference library of maps - set of 4 as listed above...

postpaid $3.50

See your favorite dealer or order direct.

WASHINGTON, D.C.
RADIO AMATEURS
DEPT. E
925 Sherwood Drive
Lake Bluff, Ill. 60044

For WRITE FOR FREE BROCHURE!

A HANDSOME PAIR
MATCHING
BOUND VOLUMES and BINDERS
Binders $3.95
1969 & 1970
Bound Volumes each $14.95
HAM RADIO MAGAZINE
GREENVILLE, N. H. 03048

MORE RANGE . . .
with NO NOISE
FOR ALL
MOBILE UNITS

ELIMINATE IGNITION NOISE
ELECTRO-SHIELD®
YOUR ENGINE
FROM $44.95

ESTES ENGINEERING CO.
543A W. 184th St., Gardena, Calif. 90248

F.M. MOTOROLA GOVERNMENT
SURPLUS
Used Re-Cond:
R-394 RECEIVER 152-172 MC $14.95 $22.50
T-278 TRANSMITTER 152-172 MC 18.95 24.95
R-257 RECEIVER 25-50 MC 19.95
T-208 TRANSMITTER 25-50 MC 29.95
Also — Power Supplies
Amplifiers
Modules, Etc.
Write — Dept. HR

Send For Our BIG CATALOG No. 71

FAIR RADIO SALES
P. O. Box 1105 - LIMA, OHIO - 45802

FIRE & BURGLAR ALARMS
1971 Handbook & Catalog
Save Hundreds of Dollars
Professional equipment from famous manufacturers. Easy step by step illustrated instructions, no special tools required. Save up to 75%. This handbook is a must for every homeowner and businessman. Just $1 cash, check or M.O.
Write W1JFT
ALARM COMPONENT DISTRIBUTORS
33 NEW HAVEN AVE., DEPT. HR
MILFORD, CONN. 06460

KOJO AUDIO FILTERS FOR SSB AND CW
The KOJO audio filters can greatly improve reception on all receivers, even the most sophisticated receivers. Large amounts of high-frequency hiss, background noise and sideband buckshot can be removed.
The SSB filter is of a low pass configuration, designed with a sharp cutoff to provide a rejection of better than 30 decibels at all ham band frequencies above approximately 3500 Hz. The filter is specifically designed to be placed in a low-impedance line for headphones or speaker.
The CW filter has a spot frequency of 780 Hz and a passband of 1100 Hz with a reference level 40 decibels below the signal level at the design frequency. The peak of the passband is 100 Hz wide at the —3 decibel reference points. The CW filter is specifically designed for low-impedance input and high-impedance output. High-impedance crystal earphones are recommended. However, with low-impedance earphones a small auxiliary amplifier or impedance matching transformer may be used.
KOJO filters are made up of top grade coils and components and are available in easy to assemble kit form with simplified instructions, or in a deluxe model. The deluxe model is completely built up and ready for use and is enclosed in a Gray cabinet® with convenient IN-OUT switch.
Try a KOJO and see what you can hear now and could not clearly hear before.
*Slight cabinet layout changes subject to take place without notice.
CW Filter Kit $ 7.95 Deluxe CW Filter $15.95
SSB Filter Kit $11.95 Deluxe SSB Filter $19.95
All filters shipped postpaid. Arizona residents add 4% sales tax.

THE J. LYNCH CO.
P. O. Box 7774, Phoenix, Arizona 85011

More Details? CHECK-OFF Page 94
... for literature, in a hurry — we'll rush your name to the companies whose names you “check-off”

INDEX

- Alarm
- American Crystal
- Antec
- Arizona
- Baker & Winnay
- Barry
- Bob-Frank
- Bob's
- Bristol
- Circuit Specialists
- Collins
- Comdel
- Communications World
- Comtec
- Curtis
- Cushecraft
- Digi-Key
- Drake
- DyComm
- Dynamic Technology
- Ehrhorn
- Eimac
- Electronic Distributors
- Erikson
- Estes
- Fair
- Goodheart
- Gray
- H & H
- H & L
- HAL
- Heights
- Henry
- International Crystal
- J & J
- Jan
- Justin

August 1971
Please use before September 30, 1971

Tear off and mail to
HAM RADIO MAGAZINE — “check-off”
Greenville, N. H. 03048

NAME

CALL

STREET

CITY

STATE.. ZIP

Advertisers index

Alarm Component Distributors ........................................ 93
American Crystal Co. .................................................. 84
Antec Co. ............................................................... 92
Arizona Semiconductor .................................................. 87
Baker & Winnay ......................................................... 86
Barry Electronics .......................................................... 89
Bob-Frank Electronics ................................................... 92
Bob's Discount Electronics ............................................... 90
Bristol Radio & Electric Co. ............................................. 67
Circuit Specialists Co. .................................................... 78
Collins Radio Co. .......................................................... 75
Comdel Inc. .............................................................. 76
Communications World, Inc. ........................................... 86
Comtec Books ............................................................... 76, 84
Curtis Electronics ......................................................... 92
Cushcraft Corp. ............................................................ 86
Digi-Key ........................................................................ 91
Drake Co., R. L. ............................................................. 77
Dynamic Communications, Inc. ......................................... 48, 49
Dynamic Technology International, Inc. .............................. 80
Ehrhorn Technical Operations ........................................... Cover I
Eimac Division of Varian .................................................. Cover IV
Electronic Distributors, Inc. ............................................. 89
Erikson Communications .................................................. 84
Estes Engineering Co. ..................................................... 93
Fair Radio Sales ............................................................. 93
G & G Radio Electronics Co. ........................................... 81
Goodheart Co., Inc., R. E. .................................................. 81
Gray Electronics ............................................................ 86
H & H Engineering .......................................................... 90
H & L Associates ............................................................ 90
HAL Devices ................................................................. 82
Heights Manufacturing Co. ............................................. 80
Henry Radio ................................................................. 2, 79
International Crystal Manufacturing Co. ............................ 74
Jan Crystals ................................................................. 87
Justin, Inc. ................................................................. 68
KW Electronics Ltd. .......................................................... 87
LA Electronic Sales ......................................................... 43, 69, 91
Lee Electronic Labs, Co. .................................................... 78
Lewispaull Electronics, Inc. .............................................. 84
Lynch Co., J. ................................................................. 93
MB Products and Sales .................................................... 90
Micro-Z Co. ................................................................. 90
Morse Telegraphers .......................................................... 86
National Radio Co., Inc. .................................................. 72
Newtronics Corp. ............................................................ 63
Palomar Engineers ........................................................... 68, 69
Penwood Numechron Co. .................................................... 91
Pickering Radio Co., Inc. ................................................... 91
RMV Electronics ............................................................ 90
RP Electronics .............................................................. 66
Radio Amateur Callbook, Inc. ........................................... 84, 88, 92
Radio Constructor .......................................................... 88
SCF Corporation ............................................................ 92
Saroc ........................................................................... 70
Savoy Electronics, Inc. ..................................................... 73
Sentry Manufacturing Co. .................................................. 91
Spectronics ................................................................. 95, 96, Cover III
Spectrum International ..................................................... 65
Structural Glass Ltd. .......................................................... 88
Surplus Electronics Co. .................................................... 90
Swan Electronics ............................................................ 71
Top-Band Systems .......................................................... 85
Tri-Rio Electronics ........................................................... 86
Vanguard Labs .............................................................. 85
WCI .......................................................... 85
Weinschenker, M. ............................................................ 35
Wheatlands ................................................................. 86
World QSL Bureau ........................................................... 91
Now you don’t have to pay twice the price to get twice the rig.

Picture this pair in your shack. The Yaesu FLdx 400 transmitter and the FRdx 400 receiver. Loaded with power. Loaded with sensitivity. Loaded with features. Loaded with value. Read on, and discover how you can have the most up-to-date receiver-transmitter rig in the world... and at an unbelievably low price.

The FRdx 400 Receiver

Get a big ear on the world with complete amateur band coverage from 160 meters through 2 meters, including WWV and CB reception. Four mechanical filters do it — they provide CW, SSB, AM and FM selectivity. Separate AM-SSB-FM detectors are included, along with squelch and transmit monitor controls. Plus a noise limiter and a variable delay AGC. And a built-in notch filter with front panel adjust for notch depth.

The FRdx includes calibration markers at 100 KHz and 25 KHz, with accurate calibrator checks verified by WWV. A solid-state FET VFO for unshakable stability. And a direct-reading 1 KHz dial affords frequency read-out to less than 200 Hertz.

The FRdx 400 sells for $359.95.

The FLdx 400 Transmitter

Here’s how to set yourself up with dual receive, transceive or split VFO operation. The FLdx 400 with its companion receiver brings you the ultimate in operational flexibility. Flexibility like frequency spotting, VOX, break-in CW, SSB, AM and even an optional FSK circuit.

The completely self-contained FLdx 400 features a built-in power supply, fully adjustable VOX, a mechanical SSB filter, metered ALC, IC and PO. A completely solid-state FET VFO provides rock-solid frequency stability.

We rate the FLdx 400 very conservatively. That rating guarantees you 240 W PEP input SSB, 120 W CW and 75 W AM. The FSK option will go all day at a continuous 75 W. And you get full frequency coverage on all amateur bands — 80 meters through 10 meters — with an optional provision for certain other bands that you can personally specify. For all that, you pay just $299.95.

FL2000 B Linear Amplifier

Ideal companion to the Series 400, this hand-crafted linear is another example of Yaesu’s unbeatable combination of high quality and low cost. Designed to operate at 1500 watts PEP SSB and 1000 watts CW, this unit provides superb regulation — achieved by a filter system with 28 UF effective capacity.

Other features include dual cooling fans (one for each tube), individual tuned input coils on each band for maximum efficiency and low distortion, and a final amplifier of the grounded grid type using two rugged carbon-plate 572 B tubes. Ready to operate at only $299.95.

SPECTRONICS WEST

Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST

Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

More Details? CHECK-OFF Page 94
Repair by mail.

Except for driver and finals, the Yaesu FT-101 is all solid state. Ten FET's, 3 IC's, 31 silicon transistors and 38 silicon diodes do the job—solidly. Most of these components are found on computer-type plug-in modules. Should one of them ever give you trouble, just send us the module. We'll send you a factory-new replacement by return mail.

But with the FT-101, you can expect everything but trouble. Like a built-in VOX, 25 KHz and 100 KHz calibrators, the WWV 10 MHz band, a high Q permeability tuned RF stage and a 5 KHz clarifier. All of that in a portable rig that sounds like it was home base.

The FT-101 is thirty pounds of power. You can work the world on 260 W PEP, 180 W CW or 80 W AM maximum input power. The world between 80 meters and 10 meters. And you'll hear it back with 0.3 microvolts sensitivity — and a 10 db signal-to-noise ratio.

This rig even includes 12 VDC and 117 VAC built-in power supplies right in the package. You supply the 12 or 117 volts plus an antenna and you're air-ready.

For in-motion operation, a noise blanker is essential. We didn't forget to include it in the FT-101. It picks out noise spikes and leaves you with nothing but clean, crisp signal copy.

Though plug-in modules mean quick, convenient repair, we don't really expect to hear from FT-101 owners. Unless it's on the air. Maybe that's why we unconditionally guarantee it for a year. The FT-101 — only $499.95.

SPECTRONICS WEST
Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST
Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

□ Please send new color catalog of all Yaesu products.
□ Enclosed find $__________________

Please send model(s) __________________

Name__________________________
Address________________________
City_____________________ State_____ Zip_____  

All prices F.O.B. Signal Hill, Ca.

SPECTRONICS WEST
Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST
Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

□ Please send new color catalog of all Yaesu products.
□ Enclosed find $__________________

Please send model(s) __________________

Name__________________________
Address________________________
City_____________________ State_____ Zip_____  

All prices F.O.B. Signal Hill, Ca.

SPECTRONICS WEST
Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST
Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

□ Please send new color catalog of all Yaesu products.
□ Enclosed find $__________________

Please send model(s) __________________

Name__________________________
Address________________________
City_____________________ State_____ Zip_____  

All prices F.O.B. Signal Hill, Ca.

SPECTRONICS WEST
Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST
Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567

□ Please send new color catalog of all Yaesu products.
□ Enclosed find $__________________

Please send model(s) __________________

Name__________________________
Address________________________
City_____________________ State_____ Zip_____  

All prices F.O.B. Signal Hill, Ca.

SPECTRONICS WEST
Dept. H, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST
Dept. H, Box 1457, Stow, Ohio 44224 / (216) 923-4567
For $450, you just can’t beat the Yaesu FTdx 560.

You can’t even beat it for $800.

How come the Yaesu is such a good deal?
First of all, it’s made in Japan, where people do painstaking electronic assembly work for a lot less money than they do in the U.S. Secondly, it’s probably the highest quality transceiver made anywhere in the world, regardless of cost.

Also we import the Yaesu and sell it direct to you, eliminating the usual dealer profit.

The Yaesu FTdx 560 is a fully assembled, fully guaranteed transceiver with 560 watts PEP of SSB power, 500 CW. Included in the selling price are many of the things you usually have to pay extra for. Like power supply, WWV, calibrators, VOX and the one-year warranty. And a lot more.

To see how much more you get with Yaesu, send for our new information packet. It includes things like a chart and photos that compare Yaesu and Yaesu workmanship with other transceivers, plus a complete schematic. Study this packet and you’ll see right away how much more value there is in a Yaesu.
NEW! Improved rugged 8122W's, 8121W's, 8072W's, and 8828W's, from EIMAC

EIMAC's new 8122W family of premium, second generation tubes are directly interchangeable with earlier equivalents in most FM, linear or modulated equipments.

These rugged, long life power tetrodes combine high screen dissipation and excellent thermal stability in a heavy duty structure which gives you improved performance in demanding communication circuits.

EIMAC's new design features rigid precision-wound gold plated molybdenum wire grids. The result is a direct-replacement tube with higher screen overload capability and greater resistance to shock and vibration. The EIMAC 8122W family is ideal for applications where you have experienced problems under environmental or electrical stress.

EIMAC's unique 8122W electron-gun structure is available in four anode configurations: Axial air flow cooling (8122W), Transverse air flow cooling (8121W), coolerless (8072W) and conduction cooled (8828W). Special heat sink coolers are also available upon request.

EIMAC's Application Engineering Section stands ready to assist you in designing these exceptional tubes in new equipments. Contact EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, or your nearest Varian/EIMAC Electron Tube and Device Group Sales Office.